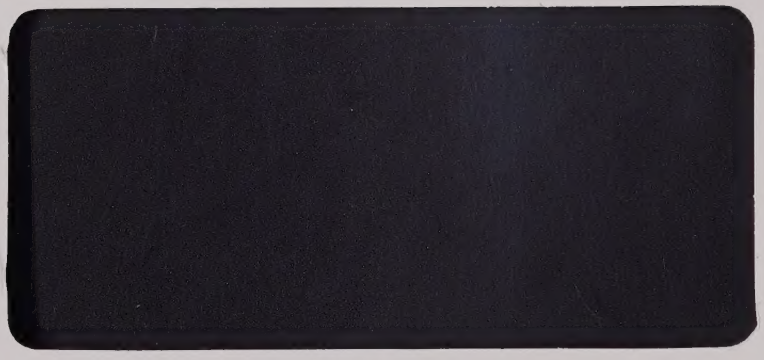
RACAL (SLOUGH) LTD.
WINDSOR

# DUAL TRACE OSCILLOSCOPE OS3001

## Instruction Manual

GOULD ADVANCE



# DUAL TRACE OSCILLOSCOPE OS3001

## Instruction Manual

GOULD ADVANCE

**Hainault Essex England**

Telephone 01-500 1000
Telegrams Attenuate Ilford
Telex 263785

# Contents


| | | |
|---|---|---|
| **SECTION 1** | **Introduction** | 3 |
| **SECTION 2** | **Specification** | 4 |
| **SECTION 3** | **Operation** | 5 |
| **3.1** | Switching On | 5 |
| **3.2** | Obtaining a Trace | 5 |
| **3.3** | Setting up Y Channels | 5 |
| **3.4** | Single Trace Operation | 5 |
| **3.5** | Dual Trace Operation | 5 |
| **3.6** | Timebase Operation | 6 |
| **3.7** | Trigger | 6 |
| **3.8** | Single Sweep Facility | 6 |
| **3.9** | External X | 6 |
| **3.10** | X-Y Mode | 6 |
| **3.11** | Additional Facilities | 7 |
| **SECTION 4** | **Circuit Description** | 8 |
| **4.1** | Block Diagram | 8 |
| **4.2** | Input Attenuators and Preamplifiers | 9 |
| **4.3** | Beam Switch | 10 |
| **4.4** | Delay Line and Delay Line Equalisers | 11 |
| **4.5** | Output Stage | 11 |
| **4.6** | Y Trigger Amplifier and Y2 Output Amplifier | 11 |
| **4.7** | Trigger Selection and Amplification | 11 |
| **4.8** | Auto | 11 |
| **4.9** | TV | 12 |
| **4.10** | Trigger Signal Routing | 12 |
| **4.11** | Schmitt Trigger | 12 |
| **4.12** | Free Run and Bright Line Circuit | 12 |
| **4.13** | Timebase Bistable | 13 |
| **4.14** | Ramp Generator | 13 |
| **4.15** | Hold Off | 13 |
| **4.16** | Single Sweep | 14 |
| **4.17** | Bright Up Amplifier | 14 |
| **4.18** | X Gate and X Output Stage | 15 |
| **4.19** | External X Amplifier | 15 |
| **4.20** | Ramp and Gate Outputs | 15 |
| **4.21** | Calibrator | 16 |
| **4.22** | Power Supplies | 16 |
| **4.23** | Cathode Ray Tube and Its Inputs | 17 |
| **4.24** | Graticule illumination | 17 |
| **SECTION 5** | **Maintenance** | 18 |
| **5.1** | General | 18 |
| **5.2** | Access | 18 |
| **5.3** | Fault Finding Tables | 19 |
| **5.4** | Operating Potentials | 19 |
| **5.5** | Calibration Procedure | 20 |
| **SECTION 6** | **Circuit Diagrams and Components Schedules** | 24 |
| **SECTION 7** | **Guarantee and Service Facilities** | 54 |

**ILLUSTRATIONS**

| | | |
|---|---|---|
| **Fig. 1** | Block Diagram | 25 |
| **Fig. 2** | Circuit Diagram, Preamp 1 and 2 and Gain Switching (AO/SK2315) | 27 |
| **Fig. 3** | Circuit Diagram, Delay Line Driver and Beam Switch (AO/SK2316) | 29 |
| **Fig. 4** | Circuit Diagram, Delay Equaliser and Output Driver (AO/SK2317) | 31 |
| **Fig. 5** | Circuit Diagram Timebase (AO/SK2339) | 35 |
| **Fig. 6** | Circuit Diagram Calibrator and External X Amp (AO/SK2340) | 37 |
| **Fig. 7** | Circuit Diagram, Bright-up and Z mod. (AO/SK2319) | 39 |
| **Fig. 8** | Circuit Diagram, X Output Amplifier (AO/SK2321) | 41 |
| **Fig. 9** | Circuit Diagram, Power Supply (AO/SK2318) | 43 |
| **Fig. 10** | Circuit Diagram, E.H.T. Supply (AO/SK2320) | 45 |
| **Fig. 11** | Circuit Diagram, Interconnection (AO/SK2338) | 47 |
| **Fig. 12** | Waveform Diagram Normal Sweep | 49 |
| **Fig. 13** | Main Frame showing access to Power supply and E.H.T. Unit | 50 |
| **Fig. 14** | Underside View | 51 |
| **Fig. 15** | Timebase P.C.B. side | 52 |
| **Fig. 16** | Fault Localisation Chart | 53 |

# Introduction

# Section 1

**OS3001 40MHz DUAL TRACE OSCILLOSCOPE**

The Advance OS3001 is a 40MHz lightweight dual-trace oscilloscope. Its facilities make it particularly suitable for general purpose and high quality laboratory work and its size and light weight suit it for portable servicing applications of an exacting nature such as computers and data processors. The high sensitivity, fast timebase speeds and excellent trigger performance make the instrument ideal for the display of fast transients.

# Specification

# Section 2

**Display**
8 x 10cm Rectangular-faced C.R.T.
E.H.T. 10kV overall
Illuminated graticule 8 x 10cm divisions with centre lines marked in 2mm divisions.
Phosphor-P31 standard, P7 optional.

**Vertical Deflection**
Two identical input channels which may be operated in chopped or alternate modes, separately or summed.
Bandwidth DC – 40MHz (–3dB) d.c. coupled
5Hz – 40MHz (–3dB) a.c. coupled
Rise time <9ns
Input coupling, DC – Ground – AC
Sensitivity 5mV/cm to 20V/cm in 1-2-5 sequence with uncalibrated fine gain control giving >2.5:1 reduction in sensitivity.
A x 5 facility on each channel gives maximum sensitivity of 1mV/cm with a bandwidth of d.c. to 10MHz
Accuracy ±3% (±5% on x 5)
Input impedance –1MΩ/28pf.
Signal Delay – at least 1 cm visible delay on fastest time base speed.
Maximum input volts d.c. plus pk a.c.) 400V

**Operating Modes**
Y1 only
Y2 only
Y1 and Y2 chopped (500kHz approx.)
Y1 and Y2 alternate
Y1 + Y2 (Algebraic addition)
NOTE: Y2 may be inverted.

**Horizontal Deflection**

| | |
|---|---|
| Sweep speeds | 22 ranges covering 200ns/cm to 2s/cm in 1-2-5 sequence. |
| Fine speed control | Reduces speed by 2.5 times (slowest scan time approx. 1 min.) x10 X expansion gives fastest timebase speed of 20ns/cm. |
| Accuracy | ±3% (±5% on x 10) |
| Trigger selection | Internal Y1, + or – slope<br>Internal Y2, + or – slope<br>External , + or – slope<br>Line , + or – slope<br>Free Run |
| Trigger input coupling | AC, DC, AC Fast, TV Frame |
| Trigger level control | (a) Manual<br>(b) Bright line auto (40Hz to 2.5MHz) |
| Trigger sensitivity | |
| Internal:– | Manual – 2mm to 5MHz, 1 cm at 40MHz<br>Auto – 3mm trace height |
| External:– | Manual – 300mV to 5MHz, 1.5V at 40MHz<br>Auto – 500mV |

**Horizontal Amplifier**
**x10 Expansion**
Operates on all timebase modes giving fastest sweep speed of 20ns/cm. Accuracy ±5%.
**External X**
Sensitivity 1V per cm
0.1V per cm on x10 expansion
Bandwidth dc – 5MHz
Input Impedance 100kΩ

**XY**
Y2 output (rear panel) coupled to Ext. X input with x10 X expand. Bandwidth dc – 1MHz
Phase shift <3° at 500kHz. Sensitivity as Y2 input attenuator (Y2 x5 inoperative)

**Ext. Z mod. (rear panel)**
Input Impedance – 47kΩ
Frequency Response – dc to 40MHz
Sensitivity: 1 volt for visible modulation at low brilliance
+20 volts for blanking from normal brilliance.

**Outputs**
Calibrator – front panel test point 1V pk-pk sq. wave ±2% 1 kHz approx.
'A' Ramp rear panel 4mm socket 0 to +10V from <10kΩ
'A' Gate " " " " 0 to +10V from <10kΩ
'B' Gate " " " " 0 to +10V from <10kΩ
Y2 out. Rear Panel BNC socket 0.1V per cm of deflection.

**Supplies**
95-111, 103-121, 111-130V ) 45 to 440Hz
190-222, 206-242, 222-260V )
Consumption 70VA approx.

**Operating temperature Range**
0-50°C
Full specification is met over range 15°C–30°C

**Size and Weight**
7" (18cm) x 11⅜" (29cm) x 16½" (42cm)
26 lbs. (11.5kg)

**Accessories supplied**
Handbook Part No. 33427

| | |
|---|---|
| 2 off BNC-BNC lead | PL43 |
| 2 off BNC-Clips lead | PL44 |
| 2 off 4mm plug | PN1244 |

**Optional accessories**

| | |
|---|---|
| Viewing Hood | PN32264 |
| Passive Probe Kit | PN31846 |
| Protective cover | PN32479 |
| Trolley | TR4 |
| Timebase Extension Lead | PL91 |

### 3.1. SWITCHING ON

CAUTION The OS3001 is convection cooled and must always be operated in a position such that air circulation through the bottom and side vents is not restricted.

1. Set the support/carrying handle to the required operating position. The handle is released by pulling outward both fixing bushes when it can then be turned to lock in any one of 5 positions.
2. ENSURE THAT THE SUPPLY VOLTAGE SELECTOR ON THE REAR PANEL IS SET TO SUIT THE VOLTAGE OF THE SUPPLY TO BE USED. The selector must not be operated while the instrument is switched on. Connect the supply.
3. Turn the BRILL control clockwise beyond the POWER OFF setting and ensure that the indicator lamp lights.

### 3.2 OBTAINING A TRACE

1. To obtain a trace
   (a) Set the Y1 shift control to approximately mid setting.
   (b) Set MODE switch to Y1.
   (c) Set the X shift control to approximately mid setting.
   (d) Set the TRIG SELECT switch to FREE RUN.
   (e) Set the TIME/CM switch to 5$\mu$s.
   (f) Set the timebase SWEEP switch to Normal.
   (g) Adjust the BRILL control to obtain a display of the required brightness.
   (h) Centralise the display by adjusting the Y1 and X shift controls.
   (i) Adjust the FOCUS control and ASTIG preset control to obtain a sharply defined trace.

### 3.3 SETTING UP Y CHANNELS

1. Using one of the coaxial input signal leads (PL43 or PL44), connect a signal to the Y1 or Y2 input socket.
2. For
   (a) Direct connection of the input signal, set the associated AC, GND, DC input lever switch to DC.
   (b) Capacitive coupling of the input signal through an internal 0.1$\mu$F 400V capacitor, set the lever switch to AC.

NOTE When examining low amplitude ac signals superimposed on a high dc level, the lever switch should be set to AC and the sensitivity of the Y amplifier increased as in 4.

3. To locate the baseline, set the lever switch to the GND setting. At this setting, the input signal is open circuit and the input of the amplifier is switched to ground.
4. To adjust the sensitivity
   (a) Set the VOLTS/CM switch to a suitable setting. To minimise pick up at sensitive settings, it is essential to ensure that the ground lead connection is near to the signal point.
   (b) If necessary,.adjust the concentric VARIABLE control.

NOTE The range of the VARIABLE control is approximately 3:1 so that its full adjustment overlaps the adjacent lower sensitivity range. Except at the CAL setting, the VARIABLE control is uncalibrated. At the CAL setting, the calibration corresponds to the setting of the VOLTS/CM switch.

5. For vertical movement of the trace, adjust the Y shift controls (identified with vertical arrows).
6. If, under no signal conditions, trace movement is detected when the VARIABLE is altered, reset the BAL preset control.

NOTE This control will only need adjustment at infrequent intervals. Before adjusting the BAL preset control however, ensure that the input lever switch is set to the GND setting.

### 3.4 SINGLE TRACE OPERATION

1. For single trace operation on the Y1 channel, set
   (a) The MODE switch to Y1.
   (b) The Y1 shift control (indicated by double ended vertical arrow) to mid setting.
2. For single trace operation on the Y2 channel set
   (a) The MODE switch to Y2.
   (b) The Y2 shift control (indicated by double ended vertical arrow) to mid setting.
3. High sensitivity operation with a bandwidth of dc to 10MHz can be obtained on either channel by pulling the SHIFT control which increases the sensitivity 5 times, i.e. 1mV/cm with the sensitivity set to 5mV/cm
   2mV/cm " " " " 10mV/cm
   4mV/cm " " " " 20mV/cm
   Beyond this it is better to revert to normal operation.
4. It is possible to obtain useful higher sensitivities with unspecified overall performance by cascading the two channels. The input signal should be coupled into Y2 and the Y2 OUTPUT socket on the rear panel coupled to the Y1 input using a coaxial connector PL43.

The MODE switch should be set to Y1. The Y2 output provides 0.1V/cm of normal Y2 display, i.e. an additional gain of x20. DC offsets and drift will necessitate the use of a.c. coupling in this mode and amplifier noise will negate the use of the full sensitivity of 50uV/cm.

### 3.5 DUAL TRACE OPERATION

In the dual trace condition, the beam switching function is in operation and results in the independent display of two signals simultaneously. Two modes of beam switching – chopped or alternate – are used, selected by the setting of the MODE switch. At any fast setting from 0.2$\mu$s/cm to 0.5ms/cm inclusive, the alternate switching mode is recommended. At slow settings from 1ms/cm to 2s/cm, inclusive and EXT X, the chopped switching mode is preferable.

1. For dual trace operation, set
   (a) The Y1 shift control to mid position.
   (b) The Y2 shift control to mid position.
   (c) Select ALT or CHOP on MODE switch.

### 3.6 TIMEBASE OPERATION

The speed of the timebase is determined by the setting of the TIME/CM switch. In addition to selection of the speed of the internal timebase, the switch has a functional setting, EXT X in which the internal timebase is inoperative.

The gain of the internal X amplifier may be increased x10 by pulling out the PULL x10 control on the VARIABLE TIME/CM switch. This facility is available at all settings including EXT X. The facility effectively increases the sweep length from 10cm to 100cm and thus allows close examination of any portion of the trace. Any portion of the increased sweep length may be selected for viewing on the display by adjusting the X shift control.

A particular advantage of this facility is to increase the maximum sweep speed to 20ns/cm.

1. To adjust the time scale of the horizontal axis
   (a) Set the TIME/CM switch to the required setting.
   (b) If necessary, adjust the concentric VARIABLE control to reduce the speed.

NOTE The range of the VARIABLE control is approximately 3:1. The VARIABLE control is uncalibrated. At the CAL setting only, the calibration corresponds to the setting of the TIME/CM switch.

Selection of the 2 sec/cm range and full use of the variable control, provides a total sweep time of approximately 1 min.

2. If close examination of any portion of the trace or the fastest sweep rates are required, operate the PULL x10 control.
3. For horizontal shift of the trace, adjust the X shift control (identified by horizontal arrow). The control has a dual speed function. Initial operation provides coarse shift control, the return adjustment provides fine shift control.

### 3.7 TRIGGER

The timebase may be operated in a FREE RUN condition or, more normally, triggered from the positive or negative slope of a signal as determined by the setting of the TRIG SELECT switch. The triggering sources selected by the TRIG SELECT switch are as follows.

(a) The supply line input frequency derived internally from the supply transformer.
(b) Y1 or Y2 amplifiers (irrespective of which beam is displayed).
(c) An external triggering source connected to the A EXT TRIG socket.

The LEVEL control concentric with the TRIG SELECT switch, allows selection of the triggering point on the trigger waveform and hence determination of the start of the horizontal trace. When the LEVEL control is set to AUTO, the trigger circuit automatically biases itself to a sensitive trigger level condition. In the absence of a trigger signal in this mode, the timebase will free run and maintain a displayed sweep at the selected speed.

The TRIG SELECT switch is used in conjunction with the TRIGGER COUPLING lever switch. This switch connects different networks into the trigger amplifier circuit and is effective at all settings of the TRIG SELECT switch.

The operating facilities available at the four settings of the lever switch are as follows.

1. AC Wideband trigger mode used for most common triggering signals.
2. ACF (AC Fast) A filter is switched into circuit to reject low frequencies. High frequency triggering may be effected from complex waveforms such as those with high ripple content or line triggering from a television video signal waveform.
3. TVF (TV Frame) A television sync separator is switched into circuit so that the timebase can be triggered from a television video waveform.
4. DC A wideband trigger mode but it is most useful at very low frequencies. The Y input coupling must also be dc for this mode to be effective on internal trigger.

Triggering control is effected as follows.

1. Set the A TRIG SELECT switch to select the required trigger signal.
2. Set the A TRIGGER COUPLING switch to the required setting.
3. On most waveforms it is convenient to select Auto. If not, adjust the LEVEL control so that the trace starts at the required point on the waveform.

If the timebase is not required to be triggered, set the A TRIG SELECT switch to FREE RUN.

NOTE If, in the Auto mode, the frequency of the trigger is less than approx. 40Hz or the amplitude is too low for reliable triggering, the timebase automatically changes to a free run condition. This condition produces a trace at the selected sweep speed.

### 3.8 SINGLE SWEEP FACILITY

To set the timebase to give a single sweep

1. Apply a repetitive waveform and obtain a trace with the SWEEP switch in NORMAL by adjusting the A LEVEL control.
2. Move SWEEP switch to SINGLE SHOT.
3. Disconnect input waveform.
4. Move SWEEP switch against the return spring arm and release.

The neon indicator will now light to show that the circuit is primed ready for the next trigger pulse to occur.

5. Apply repetitive waveform. The next trigger pulse will initiate a sweep and the neon will be extinguished. The timebase will not again operate until the SWEEP switch is moved to the ARM position again.

### 3.9 EXTERNAL X

In this condition, the external signal is applied directly to the internal X amplifier to produce a calibrated (1V/cm) horizontal deflection. Dual trace Y operation may be used if chop is selected. Bandwidth is 5MHz.

1. Set the TIME/CM switch to EXT X.
2. Connect the external signal to the EXT X socket.

### 3.10 X-Y MODE

It is possible to use the flexibility of the two Y inputs for XY displays.

1. Set the TIME/CM switch to EXT X.
2. Set the Y2 input switch to DC or AC.
3. Connect the external signal which is to be used for X deflection to the Y2 socket.
4. Select x10 X amplifier gain.
5. Couple Y2 OUT (rear panel) to EXT X input with a co-axial lead PL43.
6. Operate the Y1 channel as for single trace operation and use the Y2 VOLTS/CM switch to control the X deflection. The Y2 shift is inoperative.

## 3.11 ADDITIONAL FACILITIES

### 3.11.1 USE OF OPTIONAL PASSIVE PROBE

A x10 passive probe may be used to extend the voltage range and increase the input impedance of the Y amplifiers. The input resistance of a Y channel is 1MΩ shunted by approximately 28pF. The effective capacity of the input lead must be added to this and the resultant impedance will sometimes load the signal source. Therefore it is advisable to use a 10MΩ x 10 probe. This reduces the input capacity and increases the input resistance at the expense of the sensitivity. The probe contains a shunt RC network in series with the input, and forms an attenuator with the input RC of the Y channel. To obtain a flat frequency response it is necessary to adjust the capacitance of the probe to match the input capacity of the Y channels as follows.

1. Set the Y channel VOLTS/CM switch to 20mV/cm, and the TIME/CM switch to .2ms/cm.
2. Connect the probe to the CAL 1V pin.
3. Set the adjustable capacitor in the probe tip or termination with a small screwdriver for a level response with no overshoot or undershoot visible on the display.

### 3.11.2 CAL 1V

This pin provides a d.c. coupled positive-going square wave of 1V ±2% amplitude at approximately 1kHz frequency for calibration checks. The square wave has a source impedance of 200Ω and a rise time of less than 100ns. Shorting the CAL pin to ground will produce a square current wave-form of 5mA in the shorting link. This can be used for current probe calibration.

### 3.11.3 GATE OUTPUT

This socket on the rear panel provides a d.c. coupled positive-going square pulse of 10V amplitude from <10kΩ source impedance. The duration of the pulse is coincident with the time base sweep. Improved rise time may be obtained at the expense of amplitude by resistively loading the outputs.

### 3.11.4 RAMP OUTPUT

This socket on the rear panel provides a d.c. coupled positive-going timing ramp of approximately 10V amplitude generated by the timebase. Source impedance is 4.7kΩ and the ramp may be used as a drive for external frequency swept oscillators to allow display of voltage against frequency.

### 3.11.5 Z MOD.

This socket on the rear panel allows d.c. coupled blanking to be applied to the tube.
The C.R.T. trace is intensified by a negative input, and blanked by a positive input. The required amplitudes are

(a) 2 volts for visible brilliance modulation.
(b) +20 volts for blanking at normal brilliance.

This facility is available in any operating mode of the instrument.

For convenience, the circuit reference of any component can be used to determine its location in the instrument.

| | |
|---|---|
| 1 – 99 | Frame or interconnection. |
| 100 – 199 | Y1 and Y2 Preamplifiers and attenuators. |
| 200 – 299 | Beam switch and delay line drive amplifier. |
| 300 – 399 | Delay equaliser and Y O/P amplifier. |
| 400 – 499) 500 – 599) | Timebase |
| 600 – 699) 700 – 799) | EXT X Preamp and 1 volt Calibrator. |
| 800 – 899 | Power supply and E.H.T. supply. |
| 900 – 999 | Bright up amplifier and X output amplifier. |

e.g. R370 is part of the Y output amplifier
D801 is part of the E.H.T. oscillator.

The circuit diagrams are generally arranged for each printed board assembly or group of boards. These diagrams include some of the switches, potentiometers etc., closely associated with the circuit although these components may be mounted on the frame. Consequently not all such components appear on the interconnection diagram fig. 11 and where it makes the circuits easier to follow, some components appear on more than one circuit.

In addition to the relevant circuit diagrams, useful reference can be made to the waveform diagrams, figs. 12 when following the description of the timebase section.

## 4.1 THE BLOCK DIAGRAM

The block diagram for the complete instrument is shown in Fig. 1. It is not intended to be a full logic diagram but details the functional points of the circuit and their interrelation. The circuit can readily be divided into two main sections which are the Y and the X deflection circuits. The latter includes the time base with its associated trigger system. The bright-up or Z modulation function is described as part of the time base function.

The main X and Y signal paths for a dual trace display is indicated by the heavy lines.

### Y CHANNELS

The switched attenuator, preamplifier and trigger amplifiers are identical for the two Y channels. Y2 differs in having invert and output facilities. The state of the decade steps of attenuation and 1, 2, 5 sequence of preamp gain switching are determined by the sensitivity selected.

The use of the x5 GAIN on each channel increases their basic sensitivity to 1mV per centimetre but reduces the overall bandwidth to 10MHz.

The channel switch is a fast electronic switch with the equivalent of a changeover action as shown. It selects either the Y1 or the Y2 signal to be passed to the subsequent stages and is controlled from a bistable. In the chop mode the bistable is driven by continuous pulses from the free running multivibrator, switching the beam between the Y1 and Y2 signals as the X sweep progresses. In the alternate mode, the multivibrator acts as a monostable generating a single pulse to reverse the beam switch at the end of each time base sweep, giving alternate Y1 and Y2 sweeps. In the ADD mode, both the Y1 and Y2 switches are closed and the two signals are summed algebraically. On Y1 or Y2 only the appropriate switch is closed allowing that signal to pass.

The signal from the selected channel is passed via a delay line and amplifiers to the Y deflection plates of the CRT. This delay allows examination of that point in the waveform which initiated the sweep because the deflecting signal reaches the Y plates after the time base sweep has been initiated and the trace brightened.

### THE TIMEBASES

The purpose of the timebase system is to generate a linear ramp to deflect the spot in the X direction.
The trigger system initiates each sweep from the incoming or other signals, normally to obtain a stationary display of a repeated waveform.

### TIMEBASE OPERATION

The internal or external signal as selected is amplified by the trigger amplifier to drive a trigger circuit. If the timebase is ready to commence a sweep, a transition of the trigger circuit will set the timebase bistable which in turn initiates the ramp. This signal is passed through the X gate and X output amplifier to the X deflection plates of the C.R.T. At the end of the sweep, when the ramp reaches the required level the bistable is reset, returning the ramp to its original level. During the period of sweep the trigger gate is prevented from passing trigger pulses to the bistable and this inhibition is maintained by the hold off circuit until the ramp generator is fully recovered, ready for the next sweep to commence on the next trigger pulse, when the cycle repeats.

The bright-up amplifier normally holds the C.R.T. beam in the cut off state. The output of the bistable which allows the ramp to operate, also feeds the bright-up amplifier to raise the brilliance of the C.R.T. spot to the level determined by the brilliance control.

At the end of sweep, this output of the bistable is reset and blanks the trace during the flyback period.

If the Y channels are being switched in the chopped mode, the differentiated output of this multivibrator is also fed to the bright-up amplifier to blank the trace while the Y switching transition takes place. This leaves the appearance of two separate traces for Y1 and Y2 on the screen unless the sweep speed is higher than that normally recommended for chop operation.

### TRIGGER MODES

The trigger signal for either time base, selected from internal, external or line frequency sources, is a.c. or d.c. coupled before being fed into the trigger amplifier which is biased by the required trigger level and the resultant output passed to the trigger circuit to be squared up.

In the FREE RUN mode, the trigger gate is permanently energised and the timebase bistable is set again at the end of each hold-off period.

When AUTO coupling is selected, the trigger amplifier is automatically biased to the optimum working point for

sensitive operation of the trigger. If the signal level out of the trigger amplifier is insufficient to operate the trigger circuit, a further output from the auto circuit causes the timebase to free run, displaying the necessary bright line trace.

When TV Frame coupling is selected for the timebase, a synch. separator circuit is introduced into the signal path and the timebase is triggered by each frame pulse

In Single Sweep, the relevant bistable normally inhibits trigger pulses from reaching the timebase bistable.

When the single shot bistable is set manually, the trigger gate is opened and the next trigger pulse initiates a sweep. When the sweep starts the single sweep bistable is reset, preventing the timebase from sweeping more than once.

#### THE EXTERNAL X I/P

When external X is selected, the trace is brightened and the timebase is inhibited. The amplified X input signal passes through the X gate to the main amplifier.

### 4.2 INPUT ATTENUATORS AND PREAMPLIFIERS

NOTE The Attenuator and Preamplifiers in the Y1 channel are identical to those in the Y2 channel. Accordingly, only the Y1 channel is described. Where a corresponding component carries a different number in Y2, this number is shown in brackets after the Y1 number.

The input signal is applied from the front panel socket SKY to the 3 position lever switch, S10(S20). When the INPUT COUPLING SWITCH is in the DC position, the input signal is coupled directly to the Input Attenuator stage. In the AC position, the input signal passes through C155. This capacitor prevents the d.c. component of the input signal from passing to the amplifier. the GND position opens the signal path and connects the input circuit of the amplifier to ground. This provides a ground reference without having to disconnect the applied signal from the input connector.

The input attenuators are frequency compensated, voltage dividers. For d.c. and low frequency signals they are primarily resistance dividers and the attenuation is determined by the resistance ratio, the effect of the capacitors being negligible. However, at high frequencies, the reactance of the capacitors decreases and the attenuator becomes primarily a capacitive divider. Each attenuator contains an adjustable series capacitor to provide optimum response for the high frequency components and an adjustable shunt capacitor to set up the input capacity of each section. The component values in each section are arranged to provide the required attenuation and present the same RC characteristic for all settings of the VOLT/cm switch.

Two attenuator sections are employed giving an attenuation of 10 or 100 respectively. These are used singly or cascaded. The basic amplifier provides a maximum sensitivity (for full bandwidth) of 5mV/cm; gain switching in the amplifier reduces this to provide the 10mV/cm and 20mV/cm settings. The x10 attenuator is introduced to provide the 50, 100 and 200mV/cm ranges; the x100 to provide the 500mV, 1V, 2V/cm ranges and the x100 and x10 cascaded to provide the 5, 10 and 20V ranges.

The x10 attenuator consists of R176 and R177. Capacitor, C165 adjusts the input capacitance on the 50, 100, 200mV/cm ranges, while C167 corrects the frequency response of the attenuator.

The x100 attenuator consists of R163 and R169. Capacitor, C159 adjusts the input capacitance on 500mV, 1V, 2V/cm ranges, while C161 corrects the frequency response of the attenuator.

Capacitor, C171 provides adjustment for the input capacity when the attenuators are not in circuit. R187 determines the input resistance of the oscilloscope when the attenuators are not in circuit and contributes to the attenuating resistors on all other ranges.

The output from the attenuator is taken via the input current limiting resistor, R189, to the input stage consisting of a pair of matched field effect transistors, TR101 and TR102, operating as source followers.

The signal input is fed to the base of TR101 and the balancing potentials to the base of TR102; since these transistors are matched and coupled thermally, any drift due to temperature changes will be minimised.

The field effect transistor gives a high input impedance which does not shunt the attenuator. The signal excursion at the gate of TR101 is restricted by the limiting diodes, D101 and D102, which are returned to positive and negative potentials of approximately +6V and −6V, determined by the zener diodes, D104 and D103

The input stage drives a pair of emitter followers, TR103 and TR104, to provide a low impedance drive to the following stage.

The output from the emitter followers is applied to the long tail pair amplifier, TR121 and TR122. TR120 being a constant current source of this stage. The stage provides a nominal gain of about 5, the emitter circuit however contains the FINE GAIN CONTROL, R10 (R20), which allows a reduction in gain of at least 2:5:1. The two transistors in this stage are matched and thermally coupled together in order to reduce drift to a minimum. In addition, they are mounted on the rear screen of the attenuator assembly in close proximity to the FINE GAIN CONTROL. This ensures that the length of the emitter leads to the gain control and consequently their inductance is kept to a minimum.

A potentiometer, R123, is provided in the emitter circuit giving some variation of the collector currents. This allows the emitter potentials of the following stage to be equalised to prevent trace movement when gain switching.

The collector supply is stabilised by the 5.6V zener diode, D121, giving a collector potential of +4V. This provides sufficient margin to allow for variations of input d.c. level

due to the possible range of F.E.T. source to gate voltage.

The following stage is also a long-tailed pair with gain switching incorporated into the emitter circuit.

In the minimum gain condition the gain is determined by the emitter resistors, R132 and R134.

The gain is raised by x2 and x4 by connecting between the emitters network, R137 and R138, or network, R135 and R136, respectively.

The two trimmers, C122 and C123, provide a high frequency compensation to equalise frequency response between ranges.

Decoupled resistors, R154 and R155, are added to reduce collector dissipation and keep drift due to thermal effects to a minimum.

The collector supply is stabilised by the 5.6V zener, D122.

The final stage on this board and on the attenuator assembly is a pair of emitter followers, TR125 and TR126.

The trigger signal is taken directly from the emitters but the signal for the remainder of the Y amplifier is tapped down the emitter loads by the addition of a small series resistor. This allows a d.c. shift of the output to be provided for, balancing in the following stage by the addition of the potentiometer, R146, in the bottom end of the emitter loads.

The signal outputs from this stage represent approximately 25mV/cm of screen deflection, the d.c. level being nominally +7.5 volts.

The signals are then passed to the Beam Switch printed circuit board, in the case of Y1 direct but in the case of Y2 via the INVERT SWITCH, S201.

### 4.3 BEAM SWITCH

The Y1 and Y2 signals feed to the beam switch printed circuit board into two identical long-tail pair amplifiers, TR203/4 and TR205/6. Each amplifier provides a number of additional functions, namely:

1. SHIFT CONTROL is obtained by means of potentiometers, R26 and R27, in series with the emitter resistors of each stage.
2. Overall gain adjustment of each channel is provided for by means of the two networks, R226/R227 and R231/R232.
3. The maximum sensitivity of both Y1 and Y2 channels can be increased to 1mV/cm, this requires that the gain of these stages is increased by five times and is achieved by shunting across the emitter circuit the network, R228/R229 for Y1 and R233/234 for Y2. The switch for this function is mounted on the rear of the respective shift controls.
4. Networks, R230/C202 and R235/C206, are included to allow the h.f. response of the two channels to be matched.

The signals from this pair of amplifiers are fed to the beam switch circuit consisting of eight diodes, D201 to D208 inclusive. The switch is operated by signals applied in anti-phase to points 26 and 29 from the Beam Switch Bistable. The signal level at these points switches from approximately +7V to approximately +0.3V. Thus when point 26 rises to +7V diodes, D201 and D202, are cut-off and diodes, D203 and D204, are turned on allowing Y1 signals to pass to the following stage. At the same time, point 29 will be at approximately +0.3V allowing D205 and D206 to conduct and prevent Y2 signals reaching the following stage. When the potentials on points 26 and 29 reverse, Y2 signals will pass to the following stage and Y1 signals will be blocked.

The output from the beam switch network is taken to transistors, TR210 and TR211, connected as shunt feedback amplifiers with R249 and R250 providing feedback from the collector to base of the respective transistor. Provision is also made in this stage by means of A.O.T. resistors, R294/R295, to take out small unbalances which cause excessive trace movement when switched to the ADD mode. Also in the ADD mode it is necessary, since two stages are now connected to a common load, to remove half the resultant current in the load, this is achieved by returning R245 and R246 to the −15V line when switching to ADD.

Signals from this stage pass to the delay line driver, a further long tail pair, TR212/TR213, fed from a constant current source, TR214. A current of 10mA per side is common to this stage and, via the delay line, to the delay line terminating stage.

The Beam Switch Bistable consists of transistors, TR215 and TR216, the conducting state of these determining which channel is displayed. For single trace operation, either of the emitters is grounded via points 35 and 36. For dual trace operation, both emitters are grounded and the transistors are turned on or off by pulses from TR217 routed via capacitors, C213 and C218, and diodes, D212 and D211. In the ADD mode both emitters are open circuited raising both collector voltages and hence opening both diode gates.

The chop multivibrator contains transistors, TR217 and TR218, which operate as an emitter-coupled astable multivibrator whose frequency of approx. 500kHz is determined by R280, R285, and C221.

In addition to operation for the chop function, the circuit acts as a monostable when the alternate mode of beam switching is selected. In the alternate mode, the circuit produces 1 pulse per timebase sweep and is fed with an end of sweep pulse from the time base bistable. The −15V volts supply is connected to point 32 via the FUNCTION SWITCH, this increases the current through TR218 and causes a drop in the level of the collector voltage.

This drop cuts off TR217. The negative going end of sweep pulse thus finds the circuit in a monostable condition which it triggers producing a high amplitude positive-going pulse at the collector of TR218 and a negative-going pulse at TR217. The output from TR218 is taken to the Bright-

up Amplifier to blank the trace during the chop transistion period and that from TR217 to the Beam Switch Bistable.

### 4.4 DELAY LINE AND DELAY LINE EQUALISER

The Delay Line is of the printed circuit type and introduces a signal delay of approximately 95ns. This time allows for delay in the time base and bright-up circuits and ensures that the first part of a signal is visible.

The output of the delay line is terminated by the resistors, R301 and R302, and feeds into the common base stage, TR300 and TR301.

The pulse response for the uncompensated delay line can be represented by a fast rise for about 50% of the amplitude followed by a considerably longer rise to full amplitude. Correction for this response is provided in the following stage, TR302/TR303, by means of resistance/capacitor networks, R308/C302, R309/C303, R310/C305, R311 and C306, connected between the emitters.

A further stage, TR304/TR305, provides additional frequency compensation (C310, C311, R324/C312) and raises the signal to the required level to drive the output stage.

### 4.5 OUTPUT STAGE

The output stage consists of four transistors, TR351, TR352, TR353 and TR354, operating as a differential cascode amplifier. The collector loads are made up of four resistors in series/parallel in order to give the required dissipation with minimum stray inductance and capacitance. High frequency compensation is provided by the inductances, L351 and L352.

A constant current transistor, TR355, gives a current in each side of the output stage of approximately 35mA and holds this stable against small variations of the d.c. input level of +7.25V. At this current the nominal mean Y plate potential is +55V.

### 4.6 Y TRIGGER AMPLIFIERS AND Y2 OUTPUT AMPLIFIER

Incorporated on the Beam Switch printed circuit board are the Y1 and Y2 trigger amplifiers and the Y2 output amplifier stage.

The trigger amplifiers consist of long-tail pairs, TR201/TR202 and TR207/TR208, receiving differential signals from the Y1 and Y2 pre-amplifiers and providing a single ended output for the Time Base.

R213 and R223 provide a means of setting the d.c. level for the trigger circuits (nominally 0V).

In addition a further output is taken from the Y2 trigger amplifier and fed to an amplifying and inverting stage, TR209. This provides an output level of 100mV/cm and when used in conjunction with the X amplifier, gives an X-Y operation facility.

The gain of this stage can be set by R238 and phase shift correction is provided by C228 connected across the feedback resistor, R242.

### 4.7 "A" TRIGGER SELECTION AND AMPLIFICATION

Trigger sources (Y1, Y2, Line, Ext) are taken to S40AF. The internal trigger signals are brought via 50Ω coax, and are terminated by R400 and R406. The line trigger signal is provided from a single turn secondary winding on the mains transformer and the correct trigger voltage is obtained by the simple attenuator, R405 and R481.
External trigger signals are attenuated approximately fifty times by the network, R401, C400, R402 and C401. The signal selected by S40AF is passed via the trigger coupling switch, S42, to two cascaded emitter-follower stages, TR409 and TR410. D406 and D407 provide the necessary protection against excessively large external trigger signals. The signal from the emitter of TR410 is switched by S40BF and S40BB, according to the selected trigger slope, to the base of TR413 or TR414 which form a long-tailed pair amplifier. S40BF, S40BB also connect the undriven base of this amplifier to the network, C451, R437, and R420, which provides a low impedance path to ground for high frequency signals and the correct bias to balance the amplifier. The trigger level control (R440) also acts on this network via R441, introducing a positive or negative offset, which is thus mixed with the amplified trigger signal.

The network, R422 and C415, between the emitter of TR413 and TR414, provides high frequency compensation. The output from TR414 is applied to the base of TR415 which together with TR416, forms another long-tailed amplifier; R488, R490 and C424 provide high frequency compensation. The base of TR416 is normally held at a fixed bias by zener diode, D423, except when S41b (the auto level switch) is open (see Auto operation). When the level control (R440) is adjusted so that the base potentials of TR413 and TR414 are equal, R453 adjusts the d.c. potential on the base of TR415 so that the Schmitt trigger circuit is brought near its switching point, maintaining the same trigger level for positive and negative slope selection.

The output from the collector of TR415 is taken via D402 (see trigger signal routing) to grounded-base amplifier, TR404, and from the collector of this transistor via D401 to the Schmitt trigger circuit. The output from TR416 collector is connected to the auto level circuit, and the TV sync separator circuit.

### 4.8 AUTO

When auto is selected by turning the trigger level control to its extreme anti-clockwise position, S41a and S41b open. R491 and the base of TR416 are disconnected from the zener diode, D423, so that the d.c. potential set by R453 has little effect on the amplifier TR415 and TR416. The opening of S41 causes the potential at the extreme anticlockwise end of the level control, to change from −15V approx. to OV approx. (R440 and R552 form a potential divider across the ± 15V lines). Thus the amplifier, TR413/TR414, is still approximately balanced. S41a also

operates on TR403 (see Trigger signal routing) to energise the bright-line circuit. (See Free run and bright-line circuit). Trigger signals from the collector of TR416, are coupled, via C411 and C412, to the bases of the complementary amplifier stage; TR406 and TR407. Emitter resistors, R426 and R427, define the gain. Both transistors are normally biased off but are sensitive to small input signals with one or the other being turned on. The output resultant from the commoned collectors is an amplified form of the input, which is not paralysed by inputs of widely differing mark/space ratio. It is applied via D416 to grounded base stage, TR404, and thence to the Schmitt trigger.

### 4.9 T.V.

When T.V. is selected, by the trigger coupling switch, S42, diode D440 is turned on and allows the trigger signal at the collector of TR416 to pass via C445 to the base of TR408. A T.V. video waveform with negative sync. pulses applied to the base of TR408 will cause base current to flow and charge up C445, biasing off TR408 on all but the most negative (sync pulse) part of the signal. The collector voltage is thus composed of only the line sync signal. The low pass filter, formed by R449 and C416, extracts the frame pulse information from this waveform to be applied via D413, direct to the Schmitt trigger input.

### 4.10 TRIGGER SIGNAL ROUTING

The three different trigger circuit connections, manual trigger, auto and TV frame, are controlled by the state of TR403/TR405, and the position of the trigger coupling switch, S42. In manual operation, S41a is closed and with no voltage across its base resistor R552, TR405 is cut off. Current through R439 and R421 turns on TR403 causing its collector potential to become approximately −15V. Current through R424 and D410, pulls the collector potentials of TR406 and TR407 negative, cutting off D416, and disconnecting the auto circuit output from the grounded base amplifier, TR404. Current through R418 acts on the bright-line circuit (see Free run and bright-line circuit), to prevent it operating. Trigger signals from TR415 are passed to the Schmitt trigger as current from TR415 flows through D402 into TR404, and from the collector of TR404 via D401 to the Schmitt trigger.

When Auto is selected, S41a is open, base current through R552 bottoms TR405, and this in turn cuts off TR403. Current through R408 and D435 causes the collector of TR415 to go negative, cutting off D402. At the same time, the current through R424 and D410 is removed, allowing the collector potentials of TR406 and TR407 to rise, turning on D416. Trigger signals now pass from the collector of TR416 to the auto circuit, TR406 and TR407, and then via TR404 to the Schmitt trigger. Also, when TR403 is cut off, current through R418 is removed, energising the bright-line circuit, TR411 and TR412, and diode, D404, is turned on by current flowing through R422 enabling the Schmitt trigger output waveform to drive C407 (See Free run and bright-line circuit).

With the trigger coupling switch in the AC, ACF or DC positions, −15 volts is connected to R446 and R492, this will reverse bias diodes, D440 and D413 respectively. The Schmitt trigger circuit takes its input through D401 from TR404.

When T.V.F. is selected, these resistors are disconnected from −15 volts allowing diodes, D440 and D413, to conduct. R419 is connected to −15V, pulling the collector of TR404 negative and cutting off D401. The normal trigger signal path is interrupted and the TV frame waveform on C416 will be connected to the Schmitt trigger input.

### 4.11 SCHMITT TRIGGER

This consists of TR401, TR402 and associated components. When the base of TR401 is negative with respect to ground, TR401 is off and TR402 is on. R471 and R416 bias the base of TR402 to about 0.5 volt positive. When the base voltage of TR401 is driven positive it will start to conduct. R416 provides positive feed-back causing a rapid transition to the opposite state with TR401 conducting and TR402 cut off. When the base of TR401 returns negative, the switchover will occur at a lower level because of the change in potential across R416. This backlash prevents the trigger from responding to low level noise when biased to its operating point.

C404, R414 and C405 provide high frequency compensation of the feed-back network. One output from the Schmitt passes via D404 and C407 to the bright-line circuit while the second output is differentiated by C420 to operate the trigger gate and timebase bistable.

### 4.12 FREE RUN AND BRIGHT-LINE CIRCUIT

When Free run is selected by S40, −15V is connected to pin 9, and TR403 and TR405 are cut off by diodes D403 and D405.

In turn, TR411 is cut off and the negative movement of its collector is passed by emitter-follower, TR412 to R462. The current via R560 will now flow through D421 and R462, allowing TR417 to turn off. This will give TR437 a collector load to +15 volts. The rise in potential on the collector of TR437 is coupled into the timebase bistable, turning on TR419. This initiates the ramp. At the end of the ramp the hold off current in R458 will turn on TR437 thereby turning off the bistable for the Hold Off period. At the end of the Hold Off period the base of TR419 goes positive and the timebase bistable is again turned on. The cycle repeats as long as Free Run is selected.

When Auto is selected, TR405 is turned on, turning off TR403 and causing the time base to free run as above. When trigger signals are received and operate the Schmitt trigger, trigger pulses are routed from the Schmitt to the base of TR411. The positive transition of the collector of TR401 is transferred by D404, C407 and D415 to the base of TR411. As this transistor turns on, the rise of its collector potential is transferred via TR412, D418 and C418 in a regenerative loop to its emitter, so that TR411 bottoms, and the emitter of TR412 follows. This action turns on TR417 by supplying base current from R560 thereby inhibiting the action of TR437 for approximately 40mS, determined by C418 and R430. If no further trigger pulse is received in this period, the system will return to its free run condition. However, the regenerative action caused by any trigger pulse can be initiated at any point in the discharge of C418, and when the time base is being triggered at medium and high frequencies, the system is permanently biased in the condition which allows normal triggered operation.

### 4.13 TIMEBASE BISTABLE

TR419 and TR420 form the emitter-coupled trigger bistable. R413 normally biases off TR419 and the potential across R479 holds on TR420. A negative transition from the Schmitt trigger is coupled via C420 to TR438. This is amplified and passes via D420 to TR419 to reverse the state of the bistable.

The collectors of TR421 and TR422 provide the two buffered outputs from the bistable. TR421 provides the bright-up current pulse to the bright-up amplifier. The alternate beam switching pulse is provided from TR422 via C432 and emitter-follower, TR430. When TR420 is turned on, its collector potential falls and the diode, D422, conducts to initiate generation of the ramp as described in section 4.12. The effect is that the emitter of TR428 goes negative until D431 is brought into conduction, when TR420 is turned off and the bistable reverts to its initial condition, ready for the next trigger pulse via D420.

### 4.14 RAMP GENERATOR

The basic ramp generator is the bootstrap feedback circuit formed by f.e.t., TR426, as a source-follower with two subsequent emitter-followers, TR427 and TR428. The base-to-emitter voltages of these two transistors are approximately equal and opposite so that the emitter of TR428 follows any change of gate voltage on TR426 with an offset, which is the gate-to-source voltage of TR426 plus the potential across R508. The current in TR426 and hence the voltage between its gate and the base of TR427, is held constant, independent of actual potential as this current is the collector current of the current source, TR425.

Consequently there is a constant voltage across the selected timing resistor, Rt, which in the absence of other influences, flows to ground through the selected timing capacitor, Ct, causing the voltage across this capacitor to drop linearly. This linear ramp appears similarly on the emitter of TR428, and goes via the diode gate, D432 and D433, to the X gate. It is also tapped-off via R542 from emitter follower TR431 to the ramp output amplifier, as described in section 4-20.

The sweep speed, that is the ramp slope, is determined by the values of Ct and Rt which are selected for a particular range. Details of this range switching are shown in fig. 11. The third factor to control the sweep speed is the gate-to-source voltage of TR426 and the voltage across R508. This voltage is set by the output from the current source, TR425, which is preset by R510 and modified by the setting of R507 (the variable time/cm control).

During the flyback period when the time base bistable is reset, D422 is biased off and current flows through R546, into the emitter of TR429 and so to D429. This current is much greater than the current through Rt, so that the timing capacitor, Ct, is charged positive rapidly, and the emitter of TR428 follows until it approaches zero potential. At this point, TR432 conducts, diverting current from TR429. This subsequent reduction of the current in D429 limits when it balances the current through Rt. This is the quiescent point of the ramp generator with the emitter of TR428 approximately at zero, and the voltage on the gate of TR426 at +4V. When the timebase bistable is switched by a trigger pulse, D422 is turned on, completely removing emitter current from TR429 and reducing the current in D429 to zero. The normal ramp action then takes place with the constant current through the timing resistor, Rt negatively charging the capacitor, Ct. The capacitor charges linearly until the emitter of TR428, is at about −4V, when D431 conducts to reset the timebase bistable and complete the cycle.

### 4.15 HOLD-OFF

Triggering of the timebase bistable must be prevented or held off during the flyback period until the ramp generator has fully returned to its quiescent state. When a trigger pulse switches the timebase bistable, TR419/TR420, the collector potential of TR422 goes positive and acting through R458 pulls the base of TR437 positive. This will turn TR437 on thereby presenting a low impedance path to ground and inhibiting further trigger pulses from the Schmitt via C420. The capacitor, CHO (representing the next smallest timing capacitor in the timing series Ct) is charged negatively by the negative-going ramp on the emitter of TR431, via diode D425.

As CHO charges negative, TR418 is cut off and the current in R466 flows through R458 to cause TR437 to conduct. At the end of sweep when the time-base bistable is reset, removing the charging

current from CHO. Current through R468 slowly discharges CHO.

While the sweep generator is in its flyback period, CHO holds TR418 cut off, leaving TR437 in conduction to inhibit trigger pulses into the timebase bistable. After the ramp generator has reached its quiescent condition, CHO discharges sufficiently to allow TR418 to conduct and cut off TR437, allowing the next trigger pulse to initiate another sweep.

### 4.16 SINGLE SWEEP

This part of the circuit is based in IC401, a quad gate TTL integrated circuit connected to form two bistables. Gates, a and b, form a bistable to store the "arm" signal from the SINGLE SWEEP switch, and gates, c and d, form a bistable which acts on the hold-off circuit of the timebase to prevent trigger. When the single sweep switch is moved from NORMAL to SINGLE SWEEP, S44a grounds input 5 of IC401b. As R517 holds input 10 high, the bistable settles with 8 low and 6 high. The switch, S44b, removes the positive potential from R533 allowing R530 to turn off TR418 via D424, simulating the hold-off signal (see section 4-15) to inhibit trigger pulses. When the switch is moved to ARM position S44a grounds input 10 and the state of bistable, IC401a/IC401b, is reversed. As output 6 goes low, this negative transition is coupled through C437 and D427 to input 2 of the second bistable. This switches over and input 3 goes high, cutting off D424 and removing the hold-off condition. Then a trigger pulse is able to trigger the bistable and a normal sweep is executed. At the end of sweep, the timebase bistable resets, generating a negative-going pulse on the emitter of TR430 which is coupled by C436 to input 12 and resets the second bistable. Output 3 goes low again, turning on D424, to re-instate the hold-off and prevent further sweeps. When the single sweep switch is returned to the SINGLE SWEEP position, before, during, or after the sweep, the first bistable is reset, ready for the cycle to be initiated again after the sweep is complete. The action of this bistable avoids possible multiple triggering due to contact bounce of S44A since this switch must re-make to the SINGLE SWEEP position before the ARM condition of the bistable is removed. TR443 controls the neon indicator lamp, N400, to indicate the state of the second bistable.

### 4.17 THE BRIGHT-UP AMPLIFIER

The Bright-up amplifier which controls the Z modulation of the C.R.T. consists of an inverting amplifier, TR902, TR904 and TR903, with shunt feedback applied through R919; the base of TR902 being a virtual earth point. The inputs include current pulses from the timebase bistable (TR421), chop blanking current pulses from TR218, external Z modulation current waveforms (from emitter-follower, TR901, and R913), a d.c. current derived from the BRILLIANCE control, R60, through R912, and a bias current through R909, obtained from the timebase. The instantaneous sum of these input currents is balanced by the feedback current from the output through R919, so that the output voltage waveform follows the sum of the input currents.

The operating levels in the various display modes are tabulated below. The Brilliance control current and the Ext. Z modulation current are added through D904, the maximum brilliance condition being when the current in D904 is zero, and the blanked condition being when the current in D904 is +2mA. During the chop blanking period, a further +2mA current pulse is added which makes total applied input current >+2mA, and blanks the trace for all settings of the brilliance control.

The maximum output from the amplifier is approximately 30 volts, corresponding to this 2mA change in input current. The diode, D905, ensures that when the amplifier is overloaded by a negative input, the bright-up input does not move far from its normal working voltage.

| Display Mode | Condition | Input Current | | Total Current in D904 | Brilliance Control Range |
|---|---|---|---|---|---|
| | | Timebase Bias | Bias 'B' | | |
| EXT X | | +2mA | −2mA | 0 | Full Brill to Blanked |
| Timebase | Waiting | +2 | 0 | +2 | Blanked |
| | Running | 0 | 0 | 0 | Full Bill to Blanked |

Diodes, D908 and D909, ensure that TR904 does not bottom. TR903 provides essentially a high impedance constant current load for TR904 but C904 causes it to act, with TR904, as a complementary amplifier, to provide a low output impedance at high frequencies to drive the mainly capacitive load.

The output of the amplifier is connected via C911 directly to the grid of the C.R.T. and through R923 to the low voltage side of the floating grid supply. The d.c. voltage with respect to ground applied to the grid is then determined by the potentiometer, R928, (to allow for variations in grid cutoff between C.R.T.'s), resistor chain, R930/933, across the grid supply, and the voltage on the output of the amplifier.

The time constant, C911/R929, is much longer than the time constant, C912/R923, so that a voltage step of, say, +25V at the output of the amplifier is coupled to the grid and held by C911 and R929 while C912 rapidly charges through R923, causing the floating grid supply to rise by +25V. This causes the voltage across R928 to be reduced to zero before C911 can discharge significantly, preventing any further change in grid potential. Any voltage change on the output of the amplifier is faithfully reproduced on the grid by this means. The neons, N901 and N902, protect the C.R.T. from excessive grid-to-cathode voltage on switch-on or switch-off.

#### EXT.Z MODULATION

R903, R905, R906 and R907 form an attenuator and d.c. shift circuit for Ext. Z modulation signals. D907 and D901 are protection diodes. R913 defines an input current to the bright-up amplifier from emitter-follower, TR901. The voltage gain from the Z mod input socket to the output of the bright-up amplifier is approximately unity and high frequency signals are connected via C901, R904 and C906 to the C.R.T. cathode, so that the bandwidth of the Ext. Z modulation is not limited by the bandwidth of the bright-up amplifier.

### 4.18 X GATE AND X OUTPUT STAGE

The input of the X output amplifier can be connected to either the ramp output, or the output of the External X amplifier as determined by the timebase range switch, S43. This switching is performed by the diode gate D432/D433 for the ramp and by D602 for the External X amplifier.

When External X is selected on the timebase range switch, −15V is applied via R538 to the ramp gate, cutting it off. Simultaneously, +15V is applied to the External X amplifier supply rail, bringing its output (emitter TR602) to approximately +2V. With the ramp gate off, current flows from R615 through D602 to the emitter of TR602 thus connecting this point to the input of the X amplifier, PLB12.

With the timebase range switch in any position other than Ext. X, the ramp gate functions by applying +15V to R538. The Ext. X amplifier and gate are disabled by the removal of +15V from its supply line.

The ramp is passed to the base of TR953, one half of a long-tailed amplifier, TR953/TR954, for which TR955 is a constant current source to provide good common mode rejection. The emitter resistors of this stage can be switched to give a x10 increase in gain. The shift voltage derived from the shift control, R605 and R606, is passed by emitter follower, TR952, to the other input of the long-tailed pair. The differential output of this stage is then the sum of the ramp and shift signals. This signal is connected directly to the bases of TR958 and TR959, a long-tailed pair which is the lower part of a balanced cascode amplifier whose upper stage is TR956 and TR957. The gain of this stage is determined by the emitter feedback resistor, R982, and the load resistors, R976 and R979; R983 and C953 provide high frequency compensation. The diodes, D953, D952, D955 and D954, prevent TR956 and TR957 from saturating. The outputs from the collectors of TR956 and TR957 are taken directly to the X plates of the C.R.T.

### 4.19 EXTERNAL X AMPLIFIER

The circuit for the external X amplifier is shown in Fig. 6. The external input signal is applied to the base of the amplifier transistor, TR601, through the capacitor/resistor network, C602/R602. The trimmer, C603, is used to set the h.f. response. The diode, D601, protects the base-emitter junction of the transistor against excessive reverse voltage. Resistors, R601 and R602 together with R610, set the quiescent base voltage of the input transistor. Capacitor, C604, provides some h.f. peaking. The collector voltage swing is passed via emitter-follower, TR602, through diode, D602, (if enabled) to the X amplifier. Only when External X is selected, is the +15 volt line connected via the timebase range switch to enable the amplifier.

### 4.20 RAMP AND GATE OUTPUTS

#### THE RAMP OUTPUT

Mounted on the interconnect printed circuit board is the inverting buffer amplifier connected to the ramp via PLA1 of SKA. The ramp, running from near zero to approximately −4V, is connected directly to the base of TR951. This transistor is biased on by emitter resistors, R953 and R952. A positive-going ramp (0V to +10V) is generated across the collector load, R951, and is taken, via R954, to the output socket (SKJ).

#### THE GATE OUTPUT

This signal is taken from the collector of TR422 in the timebase. The transistor is driven from the timebase bistable and gives a positive output pulse while the ramp is running. The pulse is taken through R503 and PLA4 of SKA to the rear panel, SKK.

### 4.21 CALIBRATOR

The circuit diagram for the calibrator is included with the circuit, Fig. 6. The circuit consists of an emitter-coupled oscillator, TR603 and TR604, with C607 as the timing capacitor.

The collector current through TR604 is used to turn TR605 on and off to give a square wave output across R625. This is set by R623 to be 1 Volt peak-to-peak. The values of the resistors in the dividing chain are selected such that the output resistance is 200Ω, giving a 5mA calibrator current if the output is shorted.

### 4.22 THE POWER SUPPLIES

The OS3001 basically operates from positive and negative 15V lines and a +150V line, each stabilised and independently protected against overload. The E.H.T. lines are all obtained from a high frequency oscillator with overload protection but with direct stabilisation only on the −1.5kV C.R.T. cathode supply. This oscillator is supplied from the +20V unstabilised line used for the +15V line.

All supplies are obtained from the transformer, T83, via the range selector switch S81, the supply fuse, FS83, and the supply on/off switch, S80.

One secondary from T83 is the 6.3V supply to the CRT heater and another is the low voltage (approx. .25 Volt) for the line trigger signal. This latter voltage passes via SKB −PLB19 and PLB20 to the trigger selector switch. The three remaining secondaries are rectified and smoothed as follows.

#### 4.22.1 +15V, −15V and +150V LINES

One secondary from T83 feeds the bridge rectifier, MR83, and develops approximately 20V across capacitor, C85. This is used to obtain a stable, overload protected, −15 Volt line using an integrated circuit regulator, IC801, which contains a reference, comparator input amplifier and output current amplifier. In addition it includes the overload protection circuitry to operate from the voltage developed across the current sensing resistor, R836. The output from this IC regulator drives the external series regulator TR838.

The output of the line is set to be −15V by the preset potentiometer, R838. Components, R855 and C831, reduce the noise present on the internal reference and C832 gives feedback compensation to prevent oscillation.

A similar secondary from T83 is rectified by MR82 and develops approximately +20V across C84. Protected by FS832, this +20V supply feeds the E.H.T. oscillator.

The voltage across C84 is also used to obtain the stabilised +15 volt line. TR833, TR834, TR835 and TR837 form the +15V stabiliser circuit, which is referenced to the −15V line. If the +15V line is not at the correct potential, the junction of the two equal resistors, R847 and R848, will not be at OV. The resultant differential voltage between the bases of TR833 and TR834, will modify the collector current of TR833 to drive through TR835 to the series regulator element, TR837, and so correct the line potential.

Excessive current drawn from the +15V line will develop a potential across R835 causing D833 to conduct, in turn limiting the base current to TR835 and so also that in TR837.

Protection diodes, D835 and D836, are normally reverse biased and only conduct in the accidental condition of a short circuit between the +15V and −15V lines.

Diode, D834, protects the base-emitter junctions of TR833 and TR834 against excessive reverse voltages. Capacitors, C836 and C833, give h.f. roll-off to prevent oscillation; C835 reduces output ripple.

The third secondary from T83 is rectified by MR81 and develops approximately 180V across C83.

R84 and C86 reduce the output line ripple. The +150 Volt line is referenced from the −15 Volt line by resistors, R842 and R843. Any error potential at the junction of these resistors drives the error amplifier, TR831, which in turn controls the series transistor, TR839. Transistor, TR832, protects TR839 from over voltage at switch on, or in the event of failure of the −15V line. If the junction of the potential divider, R840 and R841, goes too far negative, TR832 conducts allowing TR839 to conduct.

Short circuit protection on the 150V line is by means of the fuse, FS831.

#### 4.22.2 E.H.T. SUPPLIES

The E.H.T. supply circuitry as shown in Fig. 10 is contained within the E.H.T. box assembly. It comprises an oscillator driving a transformer with three secondaries, each rectified to provide the three lines of approximately −1580 volts, −1500 volts and +9kV.

The oscillator is formed by the centre tapped primary winding, of the transformer in the collectors of transistors, TR814 and TR815, with feedback windings taken to the bases via protection diodes, D813 and D814. The centre tap of the primary is taken through the choke, L801, to the supply and that of the secondary being returned to the supply through R818.

The waveform at the collectors is approximately alternate half waves of 55 volts amplitude at 30kHz.

The independent grid supply from one high voltage secondary winding is rectified and smoothed by D805 and C807. The cathode supply from a further secondary is rectified and smoothed by D804 and C804, and is stabilised by a feedback circuit which controls the supply switched to the primary of the transformer.

The current through R803, (the focus control potentiometer) and R821 is compared with the reference current taken from the +15 volt line through the 'set E.H.T.' preset (R854) potentiometer on the power supply p.c. assembly and R816.

The difference signal is amplified by TR811 which controls TR812 and in turn the series regulator, TR813, which controls the supply line for the oscillator at approximately 14 volts.

Overload protection is provided when the voltage across R814 causes D811 to conduct, thereby reducing the drive into TR812. The output from TR813 is limited to approximately 600mA and if this current is maintained, the fuse FS832 on the power supply p.c. assembly will blow.

The third high voltage secondary winding is connected in series with the cathode winding to give approximately 3kV p-p a.c. input into the tripler circuit, D801, D802 and D803, with capacitors, C801, C802 and C803. The ripple present on this output is removed by the additional filter circuit, R801 and C806, and the resultant +9kV used as the P.D.A. potential for the CRT.

### 4.23 CATHODE RAY TUBE AND ITS INPUTS

The OS3001 employs a conventional mesh P.D.A. tube with a high efficiency aluminised screen.

The interconnection diagram fig. 11 shows the necessary connections to the various electrodes.

#### THE GUN

An independent winding on the mains transformer drives the heater for the cathode. The beam current and hence the spot intensity is controlled by the differential potential between the grid and cathode. The −1.5kV cathode potential is the direct stabilised output from the E.H.T. oscillator. The grid potential is the sum of the floating grid supply from the E.H.T. oscillator and the output potential of the bright-up amplifier to which the grid supply is referred.

The C.R.T. beam is brought to a clear, well focussed spot by varying the potentials applied to the focus and astigmatism electrodes. These signals are derived from R82 (focus) and R81 (astigmatism) mounted on the front panel, the latter being a screwdriver adjustment. The focus electrode is normally variable over the range −1100V to −1350V and the astigmatism from +150V to 0V.

#### THE DEFLECTION SYSTEM

The Y plates are connected to the output of the Y amplifier and the differential signal applied, deflects the beam in the vertical direction. The mean plate potential is normally +55V and the sensitivity is approx. 4.5V/cm.

Similarly, the X plates are connected to the X output amplifier and the differential signal deflects the beam in the horizontal direction. The mean X plate potential is normally +60V and the sensitivity is approx. 16V/cm.

The deflection plate shield, S1, screens the deflection plates from the other electrodes and is held at a potential of +50V obtained from the junction of R936 and R937 on the bright-up p.c. board.

The interplate shield, S2, screens the X plates from the Y plates and is held at a potential 15V more negative than the X mean plate potential, derived from the wiper of R381 on the 'Y' output p.c. board.

Shield, S3, the geometry electrode, is set for optimum linear deflection in both the X and Y axes. Its potential can be varied over the range +150V to −15V and is derived from the wiper of R851 on the power supply.

Having passed through the deflection plate system the beam accelerates to the screen which is held at +9kV by an output from the E.H.T. oscillator, striking the phosphor at high velocity to produce the necessary bright trace.

#### THE TRACE ROTATION COIL

A coil, L83, fitted round the neck of crt, inside the magnetic shield is used to align the trace with the horizontal graticule lines.

The current for this coil is taken from the preset potentiometer, R850, through R849, on the power supply board. The direction of rotation can be reversed by reversing the connection of the leads to the coil.

### 4.24 GRATICULE ILLUMINATION

The external graticule is illuminated by two lamps, ILP83 and ILP84.

The supply for these lamps is derived from the emitter-follower, TR836, on the power supply board; being set by the graticule illumination potentiometer, R80, on the front panel.

Both the emitter-follower and the control potentiometer are supplied from the full-wave rectified signal taken from the transformer at the junction of diodes, D83 and D84.

### 5.1 GENERAL

The instrument is electrically protected by three fuses as follows:—

1. 1A 'Slo-blo' Size 0 (FS80 Pt.No.21619) in the supply input and mounted on the rear panel.
2. 250mA Size 00 (FS831 Pt.No.19815) in +150V supply line and mounted on the Power Supply board.
3. 500mA Size 00 (FS832 Pt.No.5119) in the +20V line supplying the E.H.T. Oscillator also mounted on the Power Supply board.

Access to the two latter fuses is by removal of the bottom cover.

The following sections give information allowing access to and removal of the various printed circuit boards and assemblies as may be found necessary, during fault finding procedures.

If, during fault finding a component needs replacing, it should be cut from the printed circuit board as close as possible to the component, leaving the wires connected to the copper track and protruding through to the component side of the board. The new component should then be soldered into position by attaching it to these protruding wires. This protects the copper track from damage.

If a fault on a printed circuit board cannot be cleared, it is recommended that the instrument is returned to the manufacturer for repair. When faults have been cleared it is recommended that the test procedure is implemented to ensure that the instrument conforms to the specification.

### 5.2 ACCESS

Figures 14, 15, 16 and 17 illustrate various views of the instrument showing access to the majority of preset components when the top and bottom covers have been removed. Each cover is retained in position by four latch fasteners. Each fastener is released by turning it one quarter of a turn clockwise or counter-clockwise.

The construction of the instrument has been arranged so that individual boards and assemblies can be checked and components changed without actually removing the assemblies from the main frame or disconnection of cable forms. In the case of the Time Base unit this has been achieved by making it a plug-in assembly which can be removed and operated on an extension lead, PL91. This assembly is then still fully functional and access is provided to both sides of both printed circuit boards.

The following description details the method for removing the individual assemblies:—

#### 5.2.1 ATTENUATOR AND PRE-AMPLIFIER ASSEMBLY

1. Each assembly is fitted with its own screening cover and it is only necessary to remove the cover from the unit requiring attention. The procedure is identical for both attenuator assemblies.
2. Having removed the screen, take out the shift control spindle by loosening the grub screws on the universal coupling, also remove the coupling.
3. Unsolder the three supply leads and four signal leads from the rear of the horizontal printed circuit board.
4. Remove the knob from the VOLTS/cm selector switch and its fixing nut, the lever switch knob, also remove the nut behind the front panel mounted between the BNC socket and the lever switch.
5. The unit can now be removed by lifting first from the rear to clear the shift control support bracket and pulling towards the rear of the instrument.
6. Care should be taken when removing the left hand unit not to disturb the graticule illumination lamp, also ensure that this lamp is correctly positioned when the unit is replaced.
7. For fault finding, the unit may be operated out of the frame by extending the supply and signal leads. Providing that the signal leads are kept reasonably short, the complete channel may be checked at frequencies approaching the full bandwidth.

#### 5.2.2 BEAM SWITCH & DELAY LINE EQUALISER BOARD

1. Disconnect the signal leads from the rear of the board and remove the seven fixing screws.
2. The board may now be brought carefully to the upright position without unsoldering any further connections. This operation then gives access to both sides of the board.
3. If it is required to operate the board in this position, it is recommended that the output should be reconnected via extended leads.
4. Raising this board also gives access to the SHIFT control potentiometers, the x5 GAIN pull switches and the Y2 INVERT switch.

#### 5.2.3 DELAY LINE

1. The Delay Line is mounted in a tray above the tube shield, by means of four screws, two through the top of the front extrusion and two on the rear tube support assembly.

#### 5.2.4 OUTPUT BOARD

1. Remove the two Y Plate leads and the S2 connection from the tube side pins.
2. Remove the board fixing screws and also the screws attaching the output transistor heat sink to the tube support assembly.
3. The board, together with the output transistors, may now be swung out of the frame on the connecting leads giving access to both sides of the board.
4. The output transistors can be changed without removing the board by taking out the three fixing screws and lifting of the paxolin clamp.

#### 5.2.5 TIME BASE UNIT

1. Remove the fixing screws from the Time Base section of the front panel and also slacken the two fixing screws attaching the rear of the unit to the cross bar (see fig.2).
2. Carefully draw the Time Base Unit through the front of the instrument, taking care not to catch any components on the front extrusion.
3. Check that both polarising keys are still correctly positioned in the multiway connectors.
4. Both Boards are now accessible and the unit may be operated on the extension lead, PL91.

#### 5.2.6 BRIGHT-UP AMPLIFIER BOARD

1. Remove the perspex protection cover and unsolder the two leads marked:– BU BIAS and A + B.
2. Removal of the four hexagon threaded spacers allows this board to be lifted into the vertical position from the edge closest to the centre of the instrument, thus giving access to both sides.

#### 5.2.7 POWER SUPPLY ASSEMBLY

The low voltage power supply unit is on a removable subchassis mounted in the rear of the instrument.

1. Remove the screws securing the moulded rear cover, and remove the cover.
2. Remove the remaining screws holding the unit on to the rear extrusion and the screw supporting the Bright-Up Amplifier support bar.
3. Remove the four screws, XX and YY, in the rear cross bar (See fig. 2).
4. The unit may now be removed from the frame as shown in fig. 1, to the distance provided by the loop in the cable form.
5. Access is now provided to the mains transformer and VOLTAGE SELECTOR switch, smoothing capacitors and series stabiliser transistors.

#### 5.2.8 POWER SUPPLY PRINTED CIRCUIT BOARD

1. Remove the four fixing screws.
2. The board will now lift into the vertical position on its cable form giving access to both sides.

#### 5.2.9 E.H.T. UNIT

1. Remove the two screws at the top of the box, which pass through the box and into the centre bar of the instrument.
2. Lift the box out of the instrument on its cable form.
3. Remove the six screws which hold the lid and remove. Insert one of the long fixing screws through its original hole in the rear of the box and screw into the threaded insert provided in the centre bar of the instrument. This secures the unit for servicing purposes.
4. The oscillator printed circuit board and transformer are now accessible. The printed circuit board may be slid out on its runners to provide access to both sides.

#### 5.2.10 X AMPLIFIER AND INTERCONNECT BOARD

Access to this board may be obtained by removing a number of units as previously described, namely:– Time Base Unit, Bright-Up Amplifier, Power Supply Assembly and the E.H.T. unit.

#### 5.2.11 CATHODE RAY TUBE

1. Access to the base of the tube is possible by removing the moulded cover which is attached to the rear of the instrument.
2. The tube may be removed by withdrawing from the front after taking off the escutcheon and graticule assembly.
3. Before attempting to extract the tube, remove the side pin connectors and the base. It will also be necessary to unsolder the twist (trace rotation) coil leads from the interconnection printed circuit board (pins TWIST & OV). The twist coil is attached to the tube and therefore its leads should be fed through the hole in the shield as the tube is pulled forward.
4. Care should be taken when removing the tube not to bend the side pins as this may crack the glass around the seal.

### 5.3 FAULT FINDING TABLES

Faults may be localised by reference to the Fault Localisation information presented in fig. 17 and the Circuit Voltages listed in Section 5.4. The table below should be used as a general guide of voltage obtainable at certain locations within the instrument and can be used as an aid to servicing.

The power supply input voltage should be approximately at the mid range of the Supply Voltage setting. The power supply voltages in the tables are those appearing under these conditions. Other voltages assume that the Y inputs are grounded and the amplifiers are set to 5mV/cm sensitivity. The time Base is set to FREE RUN, the Y amplifiers to Y1 Mode with Y1 trace brought to the centre of the screen.

### 5.4 OPERATING POTENTIALS

#### (a) INPUT ATTENUATOR AND PRE-AMPLIFIER

| Location | | Voltage |
|---|---|---|
| TR101 and TR102 | Drains | 7.2V |
| TR101 and TR102 | Sources | 0 to +2V |
| TR103 and TR104 | Collectors | 7.8V |
| TR103 and TR104 | Emitters | +0.7 to +2.7V |
| TR121 and TR122 | Collectors | +4V |
| TR120 | Collector | –5.5V |
| TR123 and TR124 | Collectors | +6.6V |
| TR125 and TR126 | Bases | +8.6V |
| "Trig" output | | +7.9V |
| "Sig" output | | +7.6V |

#### (b) BEAM SWITCH AND DELAY LINE EQUALISATION

| Location | | Voltage |
|---|---|---|
| TR201, 202, 207 and 208 | Emitters | +8.6V |
| TR202 and TR208 | Collectors | Nominally 0V |
| TR207 | Collector | +0.8V |
| TR203, 204, 205 and 206 | Collectors | +5.4V |
| TR209 | Collector | +2.5V |
| TR209 | Base | +0.8V |
| Y2 O/P | | Nominally OV |
| TR210 and TR211 | Collectors | +6.3V |
| TR214 | Collector | +7.4V |
| Pin 31 and 33 | | +5V |
| TR215 | Collector (Y1 Selected) | +2V |
| TR215 | Collector (Y2 Selected) | +7V |
| TR217 | Collector | +13.7V |
| TR218 | Collector | +2.8V |
| TR300 and TR301 | Emitters | +4.1V |
| TR300 and TR301 | Collectors | –1.4V |
| TR302 and TR303 | Collectors | –2.3V |
| TR304 and TR305 | Collectors | +3.8V |
| Pins 43 and 44 | | +7.5V |

#### (c) Y OUTPUT AMPLIFIER

| Location | | Voltage |
|---|---|---|
| TR351 and TR352 | Collectors | +11.5V |
| TR355 | Collector | +5V |
| TR353 and TR354 | Collectors | +55V |
| Pin S2 | | Approx 40V |

#### (d) X OUTPUT AMPLIFIER AND INTERCONNECT

| Location | | Voltage |
|---|---|---|
| TR953 and TR954 | Collectors | −8.0V |
| TR968 and TR969 | Collectors | −5.7V |
| TR956 and TR957 | Collectors | +60V |

#### (e) BRIGHT-UP AMPLIFIER

| Location | | Voltage |
|---|---|---|
| TR901 | Emitter | +1.2V |
| TR904 | Collector (Ext X Mode, Max Brill) | +25V |
| Vg. Hi | | −1580V |
| Vk | | −1500V |

#### (f) E.H.T. SUPPLY

| Location | | Voltage |
|---|---|---|
| TR813 | Collector | +20V |
| TR813 | Emitter | +15V |
| TR811 | Collector | +17.3V |
| PDA | Connector | +9kV |

#### (g) LOW VOLTAGE POWER SUPPLY

| Location | | Voltage |
|---|---|---|
| TR837 | Collector | +20V |
| TR835 | Collector | +15.5V |
| TR833 | Collector | −0.65V |
| TR839 | Emitter | −18V |
| TR836 | Collector | +15V |
| TR838 | Collector | +8.5V |

#### (h) TIMEBASES

Operating potentials and waveforms within the timebase unit are shown in figs. 12 and 13.

**SINGLE SWEEP I.C.**

| | I.C. Pin No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lever position | Arm | 0 | 2.5V | 3.6 | 4.4 | 4.8 | 0 | 0 | 4.4 | 0 | 0 | 0 | 2.5 | 0 | 5 |
| | Single Sweep (Armed) | 0 | 2.5V | 3.6 | 0 | 0 | 4.4 | 0 | 0 | 4.4 | 4.8 | 0 | 2.5 | 0 | 5 |
| | Single Sweep (Fired) | 3.8V | 2.6 | 0 | 0 | 0 | 4.4 | 0 | 0 | 4.4 | 4.8 | 3.8 | 2.5 | 0 | 5 |

## 5.5 CALIBRATION PROCEDURE

### 5.5.1 TEST EQUIPMENT

1. Variable autotransformer. Output voltage 95 to 260V at 1A with ac rms voltmeter. (Variac).
2. Multimeter. 0-2.5kV with at least 20,000 ohms/volt sensitivity. Accuracy within 2%
3. Voltage Calibrator. 1kHz squarewave generator with amplitude 5mV to 100V. Accuracy within 1%.
4. Time Mark Generator. Marker generator of 0.5μs to 1 sec. Accuracy within 1%.
5. Squarewave Generator. 1MHz flat top square wave generator with adjustable amplitude 0.1V to 1V into 50 ohms having a rise time of less than 2ns.
6. R.F. Sinewave generator. 500kHz to 50MHz with 50kHz reference frequency. Output amplitude 25mV to 5V p-p into 50 ohms. Amplitude accuracy at 50kHz and 500kHz to 50MHz within 3%.
7. LF SineWave Generator.
8. Capacitance Standardiser. 1MΩ/28pF, BNC 50Ω termination TP19. BNC-BNC connector lead (PL43), Time Base Extension Lead PL91.
9. E.H.T. Meter 0–10kV.

NOTE Calibration should be carried out at normal ambient temperature and should not be commenced until the instrument has been operating for at least 15 mins.

### 5.5.2 SET SUPPLY RAIL VOLTAGE

1. Set the BRILL. control to minimum.
2. Set the SUPPLY VOLTAGE switch on the rear panel to suit the supply. Apply the supply voltage via the Variac set to mid range of the Supply Voltage setting.
3. Check that the GRATICULE control varies the graticule intensity and that the neon, N80, is energised.
4. Connect the multirange meter between chassis and pin '−15V' on the Power Supply printed circuit board. Adjust the voltage to −15V ±2% by means of R838.
5. Check that the voltage to chassis on the following pins on the Power Supply printed circuit board, are within the following limits,

   '+15V' +15 ±4%
   '+150V' +150V ±4%
6. Set the multirange meter to read 2500V and meter between chassis and pin 'VK' on Bright-Up Amplifier printed circuit board. Adjust R854 on Power Supply printed circuit board for a reading of −1500V.
7. Check that E.H.T. supply at the tube cavity cap connector is +9kV ±0.5kV.

### 5.5.3 SET TUBE CUT-OFF AND VISIBLE DELAY

Due to small changes in the C.R.T. control grid characteristics during warming up, the first part of the adjustment should be made as soon as a trace appears after switch-on.

1. Advance BRIGHTNESS Control to the '9 o'clock' position. Adjust R928 on Bright-Up Amplifier printed circuit board so that the trace is just not visible.
2. Set the TIME BASE controls to give a sweep rate of 20ns/cm. Inject the 1MHz fast rise pulse and adjust trigger so that the leading edge is visible.
3. Adjust trimmer, C905, on Bright-Up Amplifier printed circuit board for maximum visible delay with no brightened up spots appearing at the start of the trace.

#### 5.5.4 Z MODULATION

1. Apply a 1KHz square wave of 5V amplitude to the Z MOD socket on the rear panel and to Y1 INPUT socket with Y1 VOLTS/cm switch set to 2V.
2. Obtain a stable trace and check that the modulation is just visible.
3. Increase input to 20V p-p, check that the trace can be fully blanked and that positive signals cut off and negative signals brighten up the trace.

#### 5.5.5 X AMPLIFIER ADJUSTMENTS

These adjustments should be carried out with the TB unit on an extension lead, PL91, to give access to controls.

1. Set the TIME/cm switch to EXT X and VARI TIME/cm control to CAL.
2. Inject a 10V p-p 1kHz square wave into the EXT X socket.
3. Adjust R972 on X Amplifier and Interconnect printed circuit board, to give 10cm of X deflection.
4. Pull the Time Base x10 control.
5. Inject a 1V p-p 1kHz square wave into the EXT X socket.
6. Adjust R969 on X Amplifier and Interconnect printed circuit board to give 10cm of X deflection.
7. Inject an 8V p-p 10kHz square wave into the EXT X socket. Pull X Amp x10 'In'. Adjust C603 (Calibrator and EXT X amp printed circuit board) to remove any 'tail which extends beyond the bright spots at the extremes of the deflection.

#### 5.5.6 TIME BASE ACCURACY ADJUSTMENT

These adjustments should be carried out with the Time Base operating on an extension lead, PL91, to give access to the appropriate controls.

**A Time Base:–**

1. Set the TIME/cm to 1mS/cm, VARIABLE TIME/cm Control fully clockwise.
2. Inject 1kHz marker pulses into Y1 channel and trigger for a stable trace.
3. Adjust R510 on the Time Base printed circuit board for 1 marker pulse per cm.
4. Set the Time Base Range Switch to 0.5μs/cm, VARIABLE TIME/cm Control fully clockwise (to CAL position).
5. Inject 2MHz marker pulses into Y1 channel and trigger for a stable trace.
6. Adjust C435 on the Time Base printed circuit board for 1 marker pulse per cm.
7. Check that the TIME/cm VARIABLE gives greater than 3:1 reduction in speed.

**B Time Base:–**

The procedure should be repeated for the 'B' Time Base, adjusting R708 at 1kHz and C631 at 2MHz. These controls are situated on the 'B' Time Base printed circuit board.

#### 5.5.7 TRIGGER LEVEL SLOPE BALANCE ADJUSTMENT

Adjustment to be carried out with Time Base on Extension lead, PL91.

**A Time Base**

1. Inject a 1KHz sine wave into Y1 and set TRIGGER LEVEL control to mid-position, TRIGGER COUPLING in AC position.
2. Adjust R453 ("Slope Bal") so that there is no significant movement of the trigger point when the TRIGGER SELECT Switch is moved from "+ve to –ve".
3. Move TRIGGER COUPLING to DC position and adjust R213 to obtain the same trigger point. Repeat using Y2 channel and R223. (R213 and R223 are mounted on the Delay / Equiliser p.c.b.)

**B Time Base**

The above procedure should be repeated for the 'B' Time Base adjusting R643 to give the desired effect.

#### 5.5.8 INTERNAL 1v CAL. ADJUSTMENT

Adjustment to be carried out with Time Base on Extension lead PL91.

1. Inject 1V p-p 1kHz square wave into Y1 channel from external calibrator. Set Y1 VOLTS/cm to 0.1V and adjust VARIABLE GAIN Control to give exactly 8cm deflection.
2. Substitute internal cal. waveform for signal from external calibrator and adjust R623 to give exactly 8cm deflection.

#### 5.5.9 CHANNEL 1 & 2 FINE GAIN CONTROL BALANCE

1. Set Y1 VOLTS/cm switch to 5mV, INPUT COUPLING Switch to GND, Mode switch to Y1, Time Base to Free Run.
2. Set trace on centre line by means of Y1 shift control. Adjust front panel BAL control to give no trace movement when the Y1 FINE GAIN Control is operated.
3. Repeat procedure for Channel 2.

#### 5.5.10 CHANNEL 1 & 2 STEP ATTENUATOR BALANCE

1. Set Y1 VOLTS/cm switch to 20mV, INPUT COUPLING Switch to GND, Mode switch to Y1, Time Base to Free Run.
2. Set trace on centre line by means of Y1 SHIFT CONTROL. Adjust R123 (Y1) to give no trace movement when the VOLT/cm switch is moved to 5mV/cm.
3. Repeat procedure for Channel 2, adjusting R123(Y2).

#### 5.5.11 ADJUST TRACE ALIGNMENT

Set Time Base to 1ms/cm and TRIGGER SELECT to FREE RUN.

Adjust R850 to bring the trace parallel to the horizontal centre line. If there is insufficient range, reverse pink lead connections to pins marked "Twist" and '0V' on X Amplifier and Interconnection printed circuit board.

#### 5.5.12 GEOMETRY

Apply to Y1 INPUT a 1kHz sinewave to give an amplitude of 8cm, adjust ASTIG and FOCUS controls for a sharp display and set Time Base to display approximately 10 cycles. Adjust R851 for a compromise between horizontal and vertical deflection to eliminate pincushion and barrel distortion. Reset ASTIG and FOCUS controls if necessary.

#### 5.5.13 BACKGROUND ILLUMINATION

Adjust R381 to set voltage on S2 (Y O/P Board) to 15 volts negative with respect to the X mean plate potential.

#### 5.5.14 DELAY LINE MATCHING

1. Set Y1 VOLTS/cm switch to 20mV, inject 1MHz squarewave to give 6 cm deflection, adjust trigger to give stable trace.

2. Inspect top of waveform for any step occurring approximately 200$\mu$s after the start of the pulse.
3. If any step is present replace A.O.T. resistor, R265, with a small 220Ω carbon potentiometer on short leads, adjust for no step, measure required value and substitute fixed resistors of nearest preferred value.

#### 5.5.15 'ADD MODE' AMPLIFIER BALANCE

1. Set FUNCTION SWITCH to CHOP and bring both traces to the centre horizontal line, by means of Y1 and Y2 SHIFT controls.
2. Set the MODE SWITCH to ADD and note the direction and amount of movement of the trace. Return to CHOP Mode.
3. Add 100kΩ potentiometer across a.o.t. position, R294 or R295, to give a direction of movement the same as that given when moving from CHOP to ADD.
4. Adjust potentiometer to bring both traces to position found in '2'.
5. Re-centre traces, switch to ADD, movement should now be less than 0.5 cm.
6. Replace potentiometer with fixed resistor of the nearest preferred value.

#### 5.5.16 CHANNEL 1 and 2 GAIN ADJUSTMENT

1. Set Y1 VOLTS/cm switch to 20mV, INPUT COUPLING Switch to DC, FINE GAIN CONTROL to Cal.
2. Inject a 1kHz squarewave having an amplitude of 120mV into Y1, adjust R227 to a deflection of 6 cms.
3. Switch to 10mV range, inject 60mV and adjust R138 (Y1) to give 6 cm deflection.
4. Switch to 5mV range, inject 30 mV and adjust R136 (Y1) to give 6 cm deflection.
5. While still on 5mV range, inject 6mV, pull for X5 gain and adjust R229 to give 6 cm deflection.
6. Switch to all other ranges and inject the appropriate signal to give 6 cm deflection. Check that all ranges are accurate to within ±3%.
7. Repeat the above procedure for Channel 2 the adjustments for the 20mV, 10mV, 5mV and 1mV ranges being respectively, R231, R138 (Y2), R136 (Y2) and R233.

#### 5.5.17 CHANNEL 1 and ATTENUATOR COMPENSATION

1. Ensure that the attenuator covers are correctly fitted and that the link across the universal coupling on the SHIFT control is continuous.
2. Set Y1 VOLTS/cm switch to 20mV, INPUT COUPLING switch to DC, Inject 200mV 1kHz squarewave via the 28pF/1MΩ standardiser. Trigger for stable trace.
3. Adjust input trimmer, C171 (Y1) for square corner.
4. Remove standardiser, switch VOLTS/cm to 0.2V, inject 1V squarewave and adjust x10 compensating trimmer, C167 (Y1), for square corner.
5. Inject 2V squarewave via standardiser and adjust x10 input trimmer, C165 (Y1), for square corner.
6. Remove standardiser, switch VOLTS/cm to 2V, inject 10V squarewave and adjust x100 compensating trimmer, C161 (Y1), for square corner.
7. Inject 20V squarewave via standardiser and adjust x100 input trimmer, C159 (Y1), for square corner.
8. Remove standardiser and check all attenuator ranges, applying the appropriate amplitude, to ensure all ranges give a square corner to the applied waveform and are accurate to within ±3%.
9. Repeat above for Channel 2 the component numbering is the same except for a suffix 'Y2'.

#### 5.5.18 Y2 OUTPUT AMPLITUDE AND PHASE ADJUSTMENT

1. Set Y1 and Y2 INPUT VOLTS/cm switches to 0.1V. INPUT COUPLING Switches to DC. Link Y2 OUTPUT to Y1 INPUT. FUNCTION SWITCH to ALT. FINE GAIN CONTROL to CAL.
2. Inject 0.5V 1kHz squarewave into Y2 input, trigger for a stable trace.
3. Adjust R238 to give equal deflections on Y1 and Y2 (i.e. Y2 Output of 100mV/cm).
4. Remove Y2 OUTPUT link from Y1 INPUT and take to EXT X and PULL x10.
5. Apply a sine wave source to Y1 and Y2. Adjust input level to give a convenient size display which should be a 45° line at low frequencies.
6. With input frequency of 500kHz, adjust capacity (approx 15pF) C228 (a.o.t.) until ellipse just closes. (Max. phase shift 3°, d.c. – 500kHz).

#### 5.5.19 Y AMPLIFIER OVERALL PULSE RESPONSE

1. Set Y1 and Y2 VOLTS/cm switch to 20mV, INPUT COUPLING Switch to DC. Ensure that the A.O.T. R230 and R235 are initially not in circuit. FINE GAIN CONTROLS to CAL.
2. Select Y1 Mode and inject 100mV squarewave at 50kHz. Adjust R324 to give optimum flat top response.
3. Change input frequency to 500kHz. Adjust R357 and C357 for optimum flat top response.
4. Change input frequency to 1MHz. Adjust R309 and R311 to give a response having approximately 20% undershoot over the first 35-40ns.
5. Adjust C311 to improve the edge response without affecting adjustment 4.
6. Connect a small carbon 1kΩ potentiometer on short leads across a.o.t. pins R230. Adjust potentiometer and C202 to remove undershoot left in adjustment 4. Replace potentiometer with fixed resistor.
7. Inject 1MHz signal into Y2 and repeat adjustment 6 to establish correct value of R235.
8. Adjust C211 to give improvement in, without increasing, overshoot over first 15$\mu$s.

#### 5.5.20 5mV and 10mV H.F. COMPENSATION

1. Set Y1 and Y2 VOLTS/cm switch to 10mV, INPUT COUPLING SWITCH to DC, FINE GAIN CONTROL to CAL.
2. Select Y1 Mode and inject 50mV squarewave at 1MHz. Adjust C123 (Y1) to give a square corner.
3. Switch to 5mV/cm, inject 25mV and adjust C122 (Y1) to give a square corner.
4. Repeat 2 and 3 for Y2 input, adjusting C123 (Y2) and C122 (Y2) respectively.

#### 5.5.21 BANDWIDTH

1. Set Y1 and Y2 VOLTS/cm switches to 20mV, INPUT COUPLING SWITCH to DC, FINE GAIN CONTROL to CAL.

2. Select Y1 Mode and inject 50kHz from the Constant Amplitude Generator to give 5cm deflection. Increase the frequency of the generator until the display amplitude falls to 3.5 cms. This frequency should be greater than 40MHz.
3. Repeat '2' for 10mV and 5mV positions on Y1 and for 20, 10, and 5mV positions on Y2.
4. Repeat to 1mV/cm on both channels, the bandwidth should be greater than 10MHz.

#### 5.5.22 CHOP WAVEFORM COMPENSATION

1. If any of the transistors or diodes associated with the beam switch are changed it may be necessary to readjust the capacitive balance of the circuit.
2. Set INPUT COUPLING SWITCH to GND, couple the collector voltage of TR218 (R283) to EXT TRIG via a probe. Turn the TRIG SELECT to EXT.
3. Switch to CHOP Mode and set the two traces 0.5cm either side of the centre line by means of the SHIFT controls and adjust the Time Base (1$\mu$s/cm) so that individual chop transitions are visible.
4. Small amounts of capacity should be added between points 26 and 25 or 26 and 27 for Y1, and between 29 and 28 or 28 and 30 for Y2, to ensure that the chop transitions are flat and parallel to the centre line. The capacity required is usually small and is most easily achieved by using short lengths of enamelled copper wire twisted together.

#### TIMEBASE WAVEFORMS

These were drawn under the following conditions. The timebase was switched to 0.1ms/cm. A 5cm 10kHz square wave was applied to Y1 channel, and the trigger set to Y1 +ve slope.

## ABBREVIATIONS USED FOR COMPONENT DESCRIPTIONS

### RESISTORS

| | | | | |
|---|---|---|---|---|
| CC | Carbon Composition | ½W | 10% | unless otherwise stated |
| CF | Carbon Film | ⅛W | 5% | unless otherwise stated |
| MO | Metal Oxide | ½W | 2% | unless otherwise stated |
| MF | Metal Film | ¼W | 1% | unless otherwise stated |
| WW | Wire Wound | 6W | 5% | unless otherwise stated |
| CP | Control Potentiometer | | | |
| PCP | Preset Potentiometer Type MPD, PC | | | |

### CAPACITORS

| | | | | |
|---|---|---|---|---|
| CE(1) | Ceramic | | + 80%<br>− 25% | |
| CE(2) | Ceramic | 500V | ± 10% | unless otherwise stated |
| SM | Silver Mica | | | |
| PF | Plastic Film | | ± 10% | unless otherwise stated |
| PS | Polystyrene | | | |
| PE | Polyester | | ± 10% | unless otherwise stated |
| PC | Polycarbonate | | | |
| E | Electrolytic (aluminium) | | + 10%<br>− 50% | |
| T | Tantalum | | + 10%<br>− 50% | |

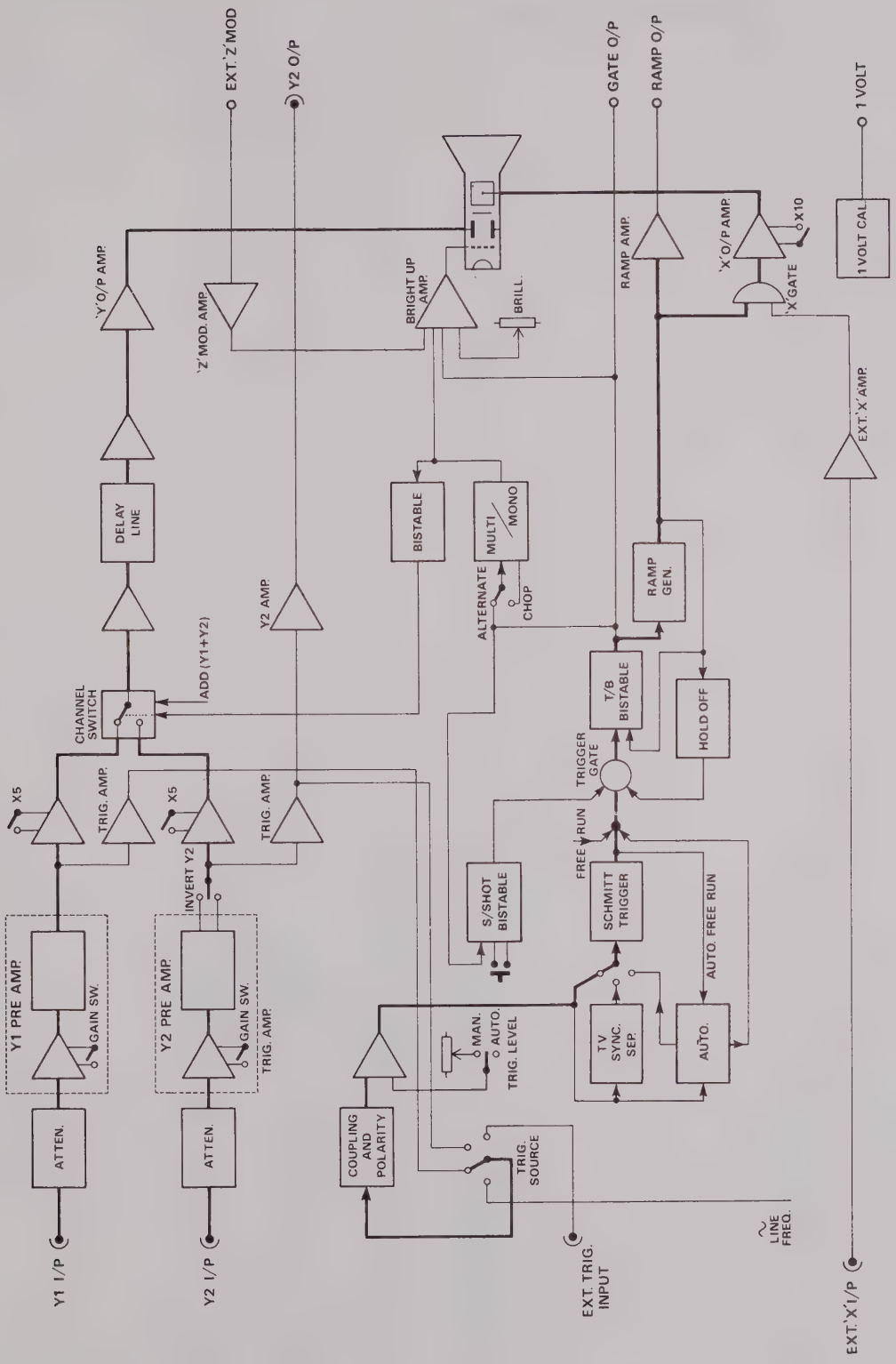


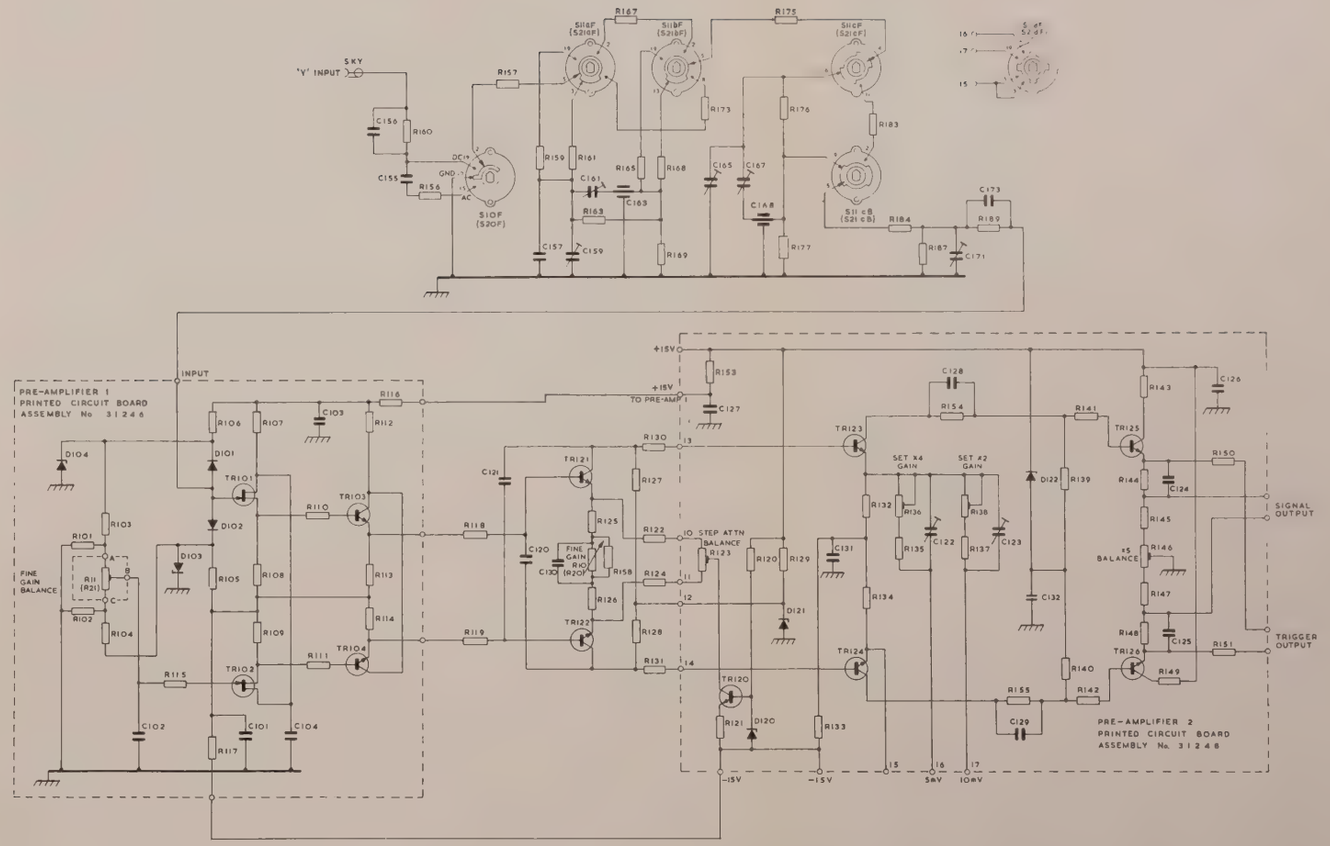

*Fig. 1 Block Diagram.*

## PRE-AMP 1 & 2 AND GAIN SWITCHING OS3001

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **RESISTORS** | | | | |
| R10 | 470Ω | CP. Lin. | | 31277 |
| R11 | 500Ω | CP. Lin. | | A4/31250 |
| R20 | 470Ω | CF. | | 31277 |
| R21 | 500Ω | CF. | | A4/31250 |
| R101 | 270Ω | CF. | | 28720 |
| R102 | 270Ω | CF. | | 28720 |
| R103 | 3k3 | CF. | | 21803 |
| R104 | 3k3 | CF. | | 21803 |
| R105 | 1k2 | CF. | | 21800 |
| R106 | 1k2 | CF. | | 21800 |
| R107 | 1k | CF. | | 21799 |
| R108 | 4k7 | CF. | | 21805 |
| R109 | 4k7 | CF. | | 21805 |
| R110 | 47Ω | CF. | | 28714 |
| R111 | 47Ω | CF. | | 28714 |
| R112 | 680Ω | CF. | | 28723 |
| R113 | 3k3 | CF. | | 21803 |
| R114 | 3k3 | CF. | | 21803 |
| R115 | 100Ω | CF. | | 21794 |
| R116 | 10Ω | CF. | | 21793 |
| R117 | 10Ω | CF. | | 21793 |
| R118 | 56Ω | CF. | | 28715 |
| R119 | 56Ω | CF. | | 28715 |
| R120 | 3k9 | CF. | | 21804 |
| R121 | 680Ω | CF. | | 28723 |
| R122 | 1k | CF. | | 21799 |
| R123 | 100Ω | CP. | | 28520 |
| R124 | 1k | CF. | | 21799 |
| R125 | 56Ω | CF. | | 28715 |
| R126 | 56Ω | CF. | | 28715 |
| R127 | 330Ω | MO. | | 26741 |
| R128 | 330Ω | MO. | | 26741 |
| R129 | 560Ω | CF. | | 21798 |
| R130 | 10Ω | CF. | | 21793 |
| R131 | 10Ω | CF. | | 21793 |
| R132 | 390Ω | MO. | | 26740 |
| R133 | 1k5 | CF. | | 21801 |
| R134 | 390Ω | MO. | | 26740 |
| R135 | 220Ω | CF. | | 21796 |
| R136 | 100Ω | CP. | | 28520 |
| R137 | 680Ω | CF. | | 28723 |
| R138 | 220Ω | CP. | | 28522 |
| R139 | 100Ω | MO. | | 26747 |
| R140 | 100Ω | MO. | | 26747 |
| R141 | 10Ω | CF. | | 21793 |
| R142 | 10Ω | CF. | | 21793 |
| R143 | 100Ω | CF. | | 21794 |
| R144 | 100Ω | CF. | | 21794 |
| R145 | 2k2 | CF. | | 21802 |
| R146 | 1k | CP. | | 26870 |
| R147 | 2k2 | CF. | | 21802 |
| R148 | 100Ω | CF. | | 21794 |
| R149 | 100Ω | CF. | | 21794 |
| R150 | 270Ω | CF. | | 28720 |
| R151 | 270Ω | CF. | | 28720 |
| R153 | 10Ω | CF. | | 21793 |
| R154 | 390Ω | MO. | | 26740 |
| R155 | 390Ω | MO. | | 26740 |
| R156 | 10Ω | CF. | | 21793 |
| R157 | 10Ω | CF. | | 21793 |
| R158 | 820Ω | CF. | | 28724 |
| R159 | | | | |
| R160 | 27Ω | CF. | | 28711 |
| R161 | | | | |
| R163 | 990k | MF. | .5 | 31927 |
| R165 | 18Ω | CF. | | 28709 |
| R167 | 10Ω | CF. | | 21793 |
| R168 | 18Ω | CF. | | 28709 |
| R169 | 10k1 | MF. | .5 | 31928 |
| R173 | 33Ω | CF | | 28712 |
| R175 | 10Ω | CF | | 21793 |
| R176 | 900k | MF | .5 | 31929 |
| R177 | 111k | MF | .5 | 31930 |
| R183 | 10Ω | CF | | 21793 |
| R184 | 10Ω | CF | | 21793 |
| R187 | 1M | MF | 1 | 26346 |
| R189 | 330k | CC | 10 | 4408 |
| **CAPACITORS** | | | | |
| C101 | .01μf | CE(2) | 25 250V | 22395 |
| C102 | .01μf | CE(2) | 25 250V | 22395 |
| C103 | .01μf | CE(2) | 25 250V | 22395 |
| C104 | .01μf | CE(2) | 25 250V | 22395 |
| C120 | 3.3pF | SM. | ½pF | 817 |
| C121 | 3.3pF | SM. | ½pF | 817 |
| C122 | 3/16pF | Trimmer | | 32059 |
| C123 | .7/6pF | Trimmer | | 29421 |
| C124 | 220pF | CE(2) | | 22379 |
| C125 | 220pF | CE(2) | | 22379 |
| C126 | .01μF | CE(2) | 25 250V | 22395 |
| C127 | .01μF | CE(2) | 25 250V | 22395 |
| C128 | .01μF | CE(2) | 25 250V | 22395 |
| C129 | .01μF | CE(2) | 25 250V | 22395 |
| C130 | 2.7pF | SM. | ½pF | 816 |
| C131 | .01μF | CE(2) | 25 500V | 22395 |
| C132 | .01μF | CE(2) | 25 500V | 22395 |
| C155 | .01μF | PE. | 10 400V | 29495 |
| C156 | 47pF | CE(2) | | 22372 |
| C157 | 10pF | SM. | 5 | 4504 |
| C159 | .7/6pF | Trimmer | | 25750 |
| C161 | .7/6pF | Trimmer | | 25750 |
| C163 | 330pF | Feed Thru' | | 31293 |
| C165 | .7/6pF | Trimmer | | 25750 |
| C167 | .7/6pF | Trimmer | | 25750 |
| C168 | 47pF | Feed Thru' | | 29918 |
| C171 | .7/6pF | Trimmer | | 25750 |
| C173 | 5600pF | CE(2) | 400V | 22394 |

**PRE-AMP 1 & 2 AND GAIN SWITCHING OS3001 (cont.)**

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **DIODES** | | | | |
| D101 | | 1N3595 | | 29330 |
| D102 | | 1N3595 | | 29330 |
| D103 | 6V2 | Zener | | 4032 |
| D104 | 6V2 | Zener | | 4032 |
| D120 | 7V5 | Zener | | 22173 |
| D121 | 5V6 | Zener | | 4109 |
| D122 | 5V1 | Zener | | 20218 |
| **TRANSISTORS** | | | | |
| TR101 TR102 | AE12 | Matched Pair | | A31253 |
| TR103 TR104 | AE13 | Matched Pair | | A31254 |
| TR120 | | 2N2369 | | 23307 |
| TR121 TR122 | AE13 | Matched Pair | | A31254 |
| TR123 | | 2N2369 | | 23307 |
| TR124 | | 2N2369 | | 23307 |
| TR125 | | 2N2369 | | 23307 |
| TR126 | | 2N2369 | | 23307 |
| **MISCELLANEOUS** | | | | |
| S10 | | Switch – lever | | A3/31292 |
| S11 | | Switch – rotary | | 31276 |
| SKY | 50Ω | BNC | | 1222 |
| L101 | | FX1242 | | 26986 |



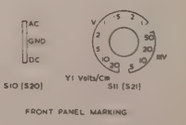




*Fig. 2 Circuit Diagram, Pre-amp 1 and 2 and Gain Switching (AO/SK2315)*

## DELAY LINE DRIVER AND BEAM SWITCH OS3001

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **RESISTORS** | | | | |
| R26 | 250Ω | CP With S12 | 20 | A4/31257 |
| R27 | 250Ω | CP With S12 | 20 | A4/31257 |
| R200 | 10Ω | CF | | 21793 |
| R201 | 10Ω | CF | | 21793 |
| R202 | 10Ω | CF | | 21793 |
| R203 | 270Ω | MO | | 26742 |
| R204 | 10Ω | CF | | 21793 |
| R205 | 10Ω | CF | | 21793 |
| R206 | 270Ω | MO | | 26742 |
| R207 | 10Ω | CF | | 21793 |
| R208 | 10Ω | CF | | 21793 |
| R209 | 10Ω | CF | | 21793 |
| R210 | 10Ω | CF | | 21793 |
| R211 | 10Ω | CF | | 21793 |
| R212 | 56Ω | CF | | 28715 |
| R213 | 100Ω | CP | | 28520 |
| R214 | 220Ω | MO | | 26743 |
| R215 | 2k2 | CF | | 21802 |
| R216 | 330Ω | MO | | 26741 |
| R217 | 180Ω | CF | | 21795 |
| R218 | 330Ω | MO | | 26741 |
| R219 | 330Ω | MO | | 26741 |
| R220 | 180Ω | CF | | 21795 |
| R221 | 330Ω | MO | | 26741 |
| R222 | 56Ω | CF | | 28715 |
| R223 | 100Ω | CP | | 28520 |
| R224 | 220Ω | MO | | 26743 |
| R225 | 1k5 | CF | | 21801 |
| R226 | 680Ω | CF | | 28723 |
| R227 | 2k2 | CP | | 24561 |
| R228 | 68Ω | CF | | 28716 |
| R229 | 100Ω | CP | | 28520 |
| R230 | | | | |
| R231 | 2k2 | CP | | 24561 |
| R232 | 680Ω | CF | | 28723 |
| R233 | 100Ω | CP | | 28520 |
| R234 | 68Ω | CF | | 28716 |
| R235 | | | | |
| R236 | 68Ω | CF | | 28716 |
| R237 | 470Ω | CF | | 21797 |
| R238 | 1k | CP | | 26870 |
| R239 | 33k | CF | | 21814 |
| R240 | 1k8 | CF | | 28725 |
| R242 | 2k2 | CF | | 21802 |
| R243 | 15k | CF | | 28727 |
| R245 | 3k9 | MO | | 26724 |
| R246 | 3k9 | MO | | 26724 |
| R247 | 470Ω | MO | | 26739 |
| R248 | 470Ω | MO | | 26739 |
| R249 | 330Ω | MO | | 26741 |
| R250 | 330Ω | MO | | 26741 |
| R251 | | | | |
| R252 | 820Ω | MO | | 26736 |
| R253 | 820Ω | MO | | 26736 |
| R254 | 22Ω | CF | | 28710 |
| R255 | 1k8 | CF | | 28725 |
| R256 | 22Ω | CF | | 28710 |
| R257 | 2k2 | CF | | 21802 |
| R258 | 10Ω | CF | | 21793 |
| R259 | 10Ω | CF | | 21793 |
| R260 | 47Ω | CF | | 28714 |
| R261 | 120Ω | CF | | 28718 |
| R262 | 390Ω | CF | | 28722 |
| R263 | 39Ω | CF | | 28713 |
| R264 | 39Ω | CF | | 28713 |
| R265 | 100Ω | CF | | 21794 |
| R266 | 56Ω | CF | | 28715 |
| R267 | 150Ω | CF | | 28719 |
| R268 | 1k | CF | | 21799 |
| R269 | 4k7 | CF | | 21805 |
| R270 | 820Ω | CF | | 28724 |
| R271 | 6k8 | CF | | 21807 |
| R272 | 6k8 | CF | | 21807 |
| R273 | 820Ω | CF | | 28724 |
| R274 | 10Ω | CF | | 21793 |
| R275 | 10Ω | CF | | 21793 |
| R276 | 4k7 | CF | | 21805 |
| R277 | 1k | CF | | 21799 |
| R278 | 150Ω | CF | | 28719 |
| R279 | 390Ω | CF | | 28722 |
| R280 | 10k | CF | | 21809 |
| R281 | 2k2 | CF | | 21802 |
| R282 | 3k3 | CF | | 21803 |
| R283 | 3k9 | CF | | 21804 |
| R284 | 1k8 | CF | | 28725 |
| R285 | 2k4 | MO | | 26729 |
| R286 | 470Ω | CF | | 21797 |
| R287 | 2k2 | CF | | 28726 |
| R288 | 10Ω | CF | | 21793 |
| R289 | 10Ω | CF | | 21793 |
| R290 | 10Ω | CF | | 21793 |
| R291 | 47Ω | CF | | 28714 |
| R292 | 47Ω | CF | | 28714 |
| R294 | | A.O.T. | | |
| R295 | | A.O.T. | | |
| R296 | 100Ω | CF. | | 21794 |
| **CAPACITORS** | | | | |
| C200 | 100pF | CE(2) | | 22376 |
| C201 | .01μF | CE(2) | 25 500V | 22395 |
| C202 | 3.5/12pF | Trimmer | | 18803 |
| C203 | .1μF | CE(1) | +80 −25 30V | 19647 |
| C204 | 100pF | CE(2) | | 22376 |
| C205 | .1μF | CE(1) | +80 −25 30V | 19647 |
| C206 | 3.5/12pF | Trimmer | | 18803 |
| C209 | 8.2pF | CE(2) | 1pF500V | 22263 |

**DELAY LINE DRIVER AND BEAM SWITCH OS3001 (Cont.)**

| Ref | Value | Description | Tol% | Part No |
|---|---|---|---|---|
| C210 | 8.2pF | CE(2) | 1pF 500V | 22363 |
| C211 | 10/40pF | Trimmer | | 29483 |
| C212 | 330pF | CE(2) | | 22381 |
| C213 | 33pF | CE(2) | | 22370 |
| C214 | .01μF | CE(2) | 25 250V | 22395 |
| C215 | 15pF | CE(2) | | 22366 |
| C216 | 15pF | CE(2) | | 22366 |
| C217 | .01μF | CE(2) | 25 250V | 22395 |
| C218 | 33pF | CE(2) | | 22370 |
| C219 | 330pF | CE(2) | | 22381 |
| C220 | .01μF | CE(2) | 25 250V | 22395 |
| C221 | 900pF | PS | 1 125V | 24885 |
| C222 | .01μF | CE(2) | 25 250V | 22395 |
| C223 | 47pF | CE(2) | | 22372 |
| C224 | .01μF | CE(2) | 25 250V | 22395 |
| C225 | .1μF | CE(1) | +80 −25 30V | 19647 |
| C226 | 22μF | E | +50 −10 25V | 32181 |
| C228 | | A.O.T. | | |

**TRANSISTORS**

| | | | |
|---|---|---|---|
| TR201 | MPS 3640 | | 24128 |
| TR202 | MPS 3640 | | 24128 |
| TR203 | AE 16 | | A31781 |
| TR204 | AE 16 | | A31781 |
| TR205 TR206 | AE 17 | Matched Pair | A4/32063 |

| Ref | Value | Description | Tol± | Part No. |
|---|---|---|---|---|
| TR207 | | MPS 3640 | | 24128 |
| TR208 | | MPS 3640 | | 24128 |
| TR209 | | 2N2369 | | 23307 |
| TR210 | | 2N2369 | | 23307 |
| TR211 | | 2N2369 | | 23307 |
| TR212 | | AE 16 | | A31781 |
| TR213 | | AE 16 | | A31781 |
| TR214 | | MPS 3640 | | 24128 |
| TR215 | | 2N2369 | | 23307 |
| TR216 | | 2N2369 | | 23307 |
| TR217 | | 2N2369 | | 23307 |
| TR218 | | 2N2369 | | 23307 |

**DIODES**

| | | | |
|---|---|---|---|
| D201 | | IN916 | 1949 |
| D202 | | IN916 | 1949 |
| D203 | | IN916 | 1949 |
| D204 | | IN916 | 1949 |
| D205 | | IN916 | 1949 |
| D206 | | IN916 | 1949 |
| D207 | | IN916 | 1949 |
| D208 | | IN916 | 1949 |
| D209 | 5V6 | Zener | 4109 |
| D210 | 3V3 | Zener | 4034 |
| D211 | | IN4148 | 23802 |
| D212 | | IN4148 | 23802 |

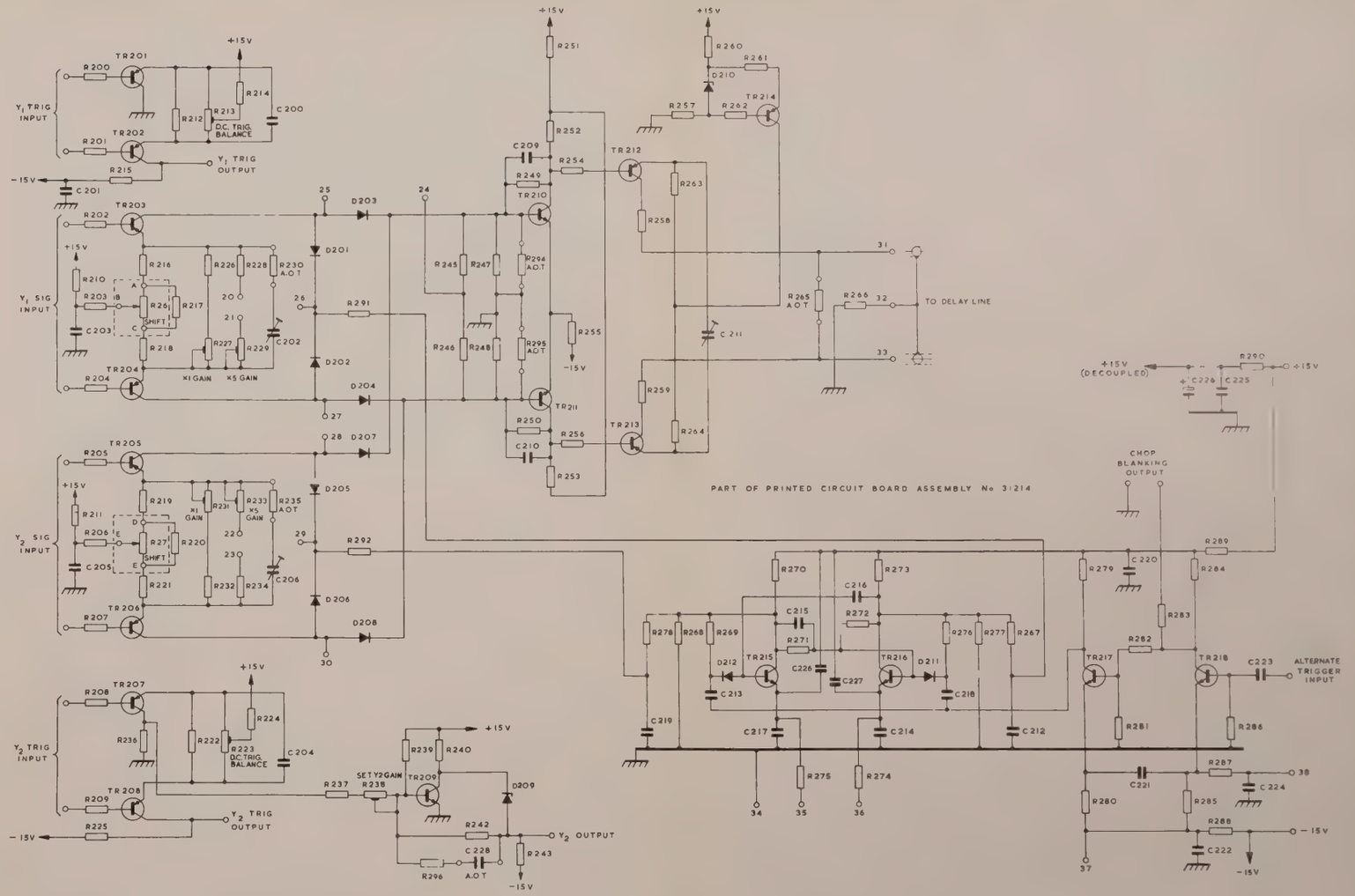



*Fig. 3 Circuit Diagram, Delay Line Driver and Beam Switch (AO/SK2316)*

## DELAY EQUALISER & OUTPUT DRIVER OS3001

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **RESISTORS** | | | | |
| R300 | 330Ω | CF | | 28721 |
| R301 | 82Ω | MO | | 28781 |
| R302 | 82Ω | MO | | 28781 |
| R303 | 3k3 | CF | | 21803 |
| R304 | 22Ω | CF | | 28710 |
| R305 | 22Ω | CF | | 28710 |
| R306 | 270Ω | MO | | 26742 |
| R307 | 270Ω | MO | | 26742 |
| R308 | 8k2 | CF | | 21808 |
| R309 | 470Ω | CP | | 28524 |
| R310 | 27k | CF | | 21813 |
| R311 | 1k | CP | | 26870 |
| R312 | 390Ω | MO | | 26740 |
| R313 | 33Ω | CF | | 28712 |
| R314 | 33Ω | CF | | 28712 |
| R315 | 100Ω | MO | | 26747 |
| R316 | 100Ω | MO | | 26747 |
| R317 | 510Ω | MO | | 26738 |
| R318 | 100Ω | MO | | 26747 |
| R319 | 100Ω | MO | | 26747 |
| R320 | 47Ω | CF | | 28714 |
| R321 | 22Ω | CF | | 28710 |
| R322 | 22Ω | CF | | 28710 |
| R323 | 10Ω | CF | AOT. | 21793 |
| R324 | 22k | CP | | 25885 |
| R325 | 3k3 | CF | | 21803 |
| R326 | 3k3 | CF | | 21803 |
| R327 | 47Ω | CF | | 28714 |
| R328 | 47Ω | CF | | 28714 |
| R329 | 560Ω | MO | | 26737 |
| R330 | 390Ω | MO | | 26740 |
| R331 | 390Ω | MO | | 26740 |
| R332 | 220Ω | CF | | 21796 |
| R333 | 270Ω | MO | | 26742 |
| R334 | 270Ω | MO | | 26742 |
| R335 | 10Ω | CF | | 21793 |
| R336 | 10Ω | CF | | 21793 |
| R337 | 10Ω | CF | | 21793 |
| R338 | 100k | CF | | 21819 |
| R339 | 1k8 | CF | | 28725 |
| R351 | 2k2 | | | 425 |
| R352 | 47Ω | CF | | 28714 |
| R353 | 39Ω | CF | | 28713 |
| R354 | 56Ω | CF | | 28715 |
| R355 | 56Ω | CF | | 28715 |
| R356 | 10Ω | CF | | 21793 |
| R357 | 100Ω | CP | | 28520 |
| R358 | 33k | CF | | 21814 |
| R359 | 10Ω | CF | | 21793 |
| R360 | 82Ω | MO | | 28781 |
| R361 | 82Ω | MO | | 28781 |
| R362 | 56Ω | CF | | 28715 |
| R363 | 56Ω | CF | | 28715 |
| R364 | 56Ω | CF | | 28715 |
| R365 | 1k | CF | 5 1W | 17758 |
| R366 | 1k | CF | 5 1W | 17758 |
| R367 | 1k | CF | 5 1W | 17758 |
| R368 | 1k | CF | 5 1W | 17758 |
| R369 | 1k | CF | 5 1W | 17758 |
| R370 | 1k | CF | 5 1W | 17758 |
| R371 | 1k | CF | 5 1W | 17758 |
| R372 | 1k | CF | 5 1W | 17758 |
| R373 | 2k2 | WW | 5 6W | 599 |
| R374 | 10Ω | CF | | 21793 |
| R380 | 56k | CF | | 28729 |
| R381 | 100k | CP | | 26582 |
| R382 | 120k | CF | | 21820 |
| R383 | 2k2 | WW | | 599 |
| **CAPACITORS** | | | | |
| C301 | .01μF | CE(2) | 25 250V | 22395 |
| C302 | .22μF | PE | 10 160V | 31379 |
| C303 | 47pF | CE(2) | | 22372 |
| C304 | .01μF | CE(2) | 25 250V | 22395 |
| C305 | 150pF | CE(2) | | 22378 |
| C306 | 47pF | CE(2) | | 22372 |
| C307 | .01μF | CE(2) | 25 250V | 22395 |
| C308 | .01μF | CE(2) | 25 250V | 22395 |
| C309 | .01μF | CE(2) | 25 250V | 22395 |
| C310 | 47pF | CE(2) | | 22372 |
| C311 | 10/40pF | Trimmer | | 29483 |
| C312 | 100pF | CE(2) | | 22376 |
| C313 | 33μF | E | +50 −10 16V | 32173 |
| C314 | 33μF | E | +50 −10 16V | 32173 |
| C315 | .01μF | CE(2) | 25 250V | 22395 |
| C316 | .01μF | CE(2) | 25 250V | 22395 |
| C317 | .01μF | CE(2) | 25 250V | 22395 |
| C318 | .01μF | CE(2) | 25 250V | 22395 |
| C319 | .01μF | CE(2) | 25 250V | 22395 |
| C320 | 39pF | CE(2) | | 22371 |
| C351 | 5600pF | CE(2) | 25 500V | 22394 |
| C352 | 100pF | CE(2) | 25 500V | 22376 |
| C353 | 100pF | CE(2) | | 22376 |
| C354 | 0.1μF | PF | 10 160V | 2740 |
| C355 | 0.1μF | PF | 10 160V | 2740 |
| C356 | .01μF | CE(2) | 25 250V | 22395 |
| C357 | 10/40pF | Trimmer | | 29483 |
| C358 | 33pF | CE(2) | | 22370 |
| **TRANSISTORS** | | | | |
| TR300 | | AE 16 | | A31781 |
| TR301 | | AE 16 | | A31781 |
| TR302 | | 2N2369 | | 23307 |
| TR303 | | 2N2369 | | 23307 |
| TR304 | | 2N2369 | | 23307 |
| TR305 | | 2N2369 | | 23307 |

## DELAY EQUALISER & OUTPUT DRIVER OS3001 (Cont.)

| Ref | Value | Description | Tol± | Part No. |
|---|---|---|---|---|
| TR351 | | 2N2369 | | 23307 |
| TR352 | | 2N2369 | | 23307 |
| TR353 | | 2N3119 | | 31255 |
| TR354 | | 2N3119 | | 31255 |
| TR355 | | 2N2369 | | 23307 |
| **DIODES** | | | | |
| D300 | 3V9 | Zener | | 3817 |
| D351 | 3V3 | Zener | | 4034 |
| L351 | 3.3μH | | | 31256 |
| L352 | 3.3μH | | | 31256 |

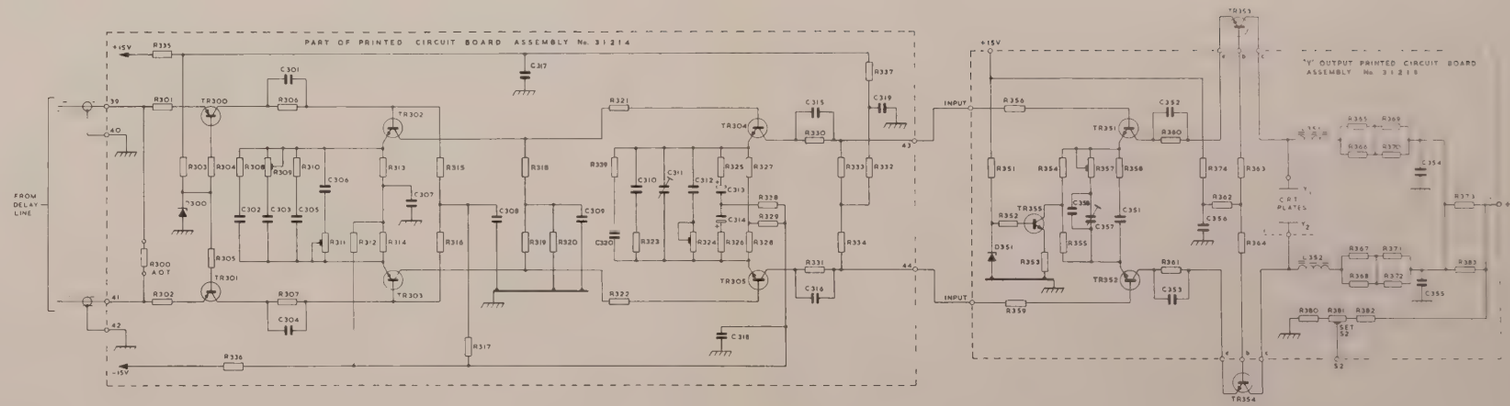



*Fig. 4 Circuit Diagram, Delay Equaliser and Output Driver (AO/SK2317)*

## TIMEBASE OS3001

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **RESISTORS** | | | | |
| R400 | 47Ω | CF | | 28714 |
| R401 | 100k | CF | | 19061 |
| R402 | 2k2 | CF | | 21802 |
| R403 | 10Ω | CF | | 21793 |
| R404 | 47Ω | CF | | 28714 |
| R405 | 47Ω | CF | | 28714 |
| R406 | 47Ω | CF | | 28714 |
| R407 | 47Ω | CF | | 28714 |
| R408 | 1k5 | CF | | 21801 |
| R409 | 10k | CF | | 21809 |
| R410 | 1k | CF | | 21799 |
| R411 | 3k9 | CF | | 21804 |
| R412 | 1k | CF | | 21799 |
| R413 | 2k7 | CF | | 28726 |
| R414 | 220Ω | CF | | 21796 |
| R415 | 1k5 | CC | | 18552 |
| R416 | 560Ω | CF | | 21798 |
| R417 | 8k2 | CF | | 21808 |
| R418 | 470k | CF | | 32330 |
| R419 | 2k2 | CF | | 21802 |
| R420 | 10k | CF | | 21809 |
| R421 | 220k | CF | | 21823 |
| R422 | 33k | CF | | 21814 |
| R423 | 22k | CF | | 21812 |
| R424 | 1k8 | CF | | 28725 |
| R425 | 33k | CF | | 21814 |
| R426 | 1k | CF | | 21799 |
| R427 | 1k | CF | | 21799 |
| R428 | 100k | CF | | 21819 |
| R429 | 470Ω | CF | | 21797 |
| E430 | 560k | CF | | 32359 |
| R431 | 100Ω | CF | | 21794 |
| R432 | 4k7 | CF | | 21805 |
| R433 | 150k | CF | | 21821 |
| R434 | 3k9 | CF | | 21804 |
| R435 | 39Ω | CF | | 28713 |
| R436 | 47Ω | CF | | 28714 |
| R437 | 15k | CF | | 28727 |
| R438 | 100Ω | CF | | 21794 |
| R439 | 10Ω | CF | | 21793 |
| R440 | | | | |
| R441 | 4k7 | CF | | 21805 |
| R442 | 22Ω | CF | | 28710 |
| R443 | 3k3 | CF | | 21803 |
| R444 | 4k7 | CF | | 21805 |
| R445 | 1k5 | CF | | 21801 |
| R446 | 22k | CF | | 21812 |
| R447 | 33k | CF | | 21814 |
| R448 | 470k | CF | | 32330 |
| R449 | 12k | CF | | 21810 |
| R450 | 4k7 | CF | | 21805 |
| R451 | 47Ω | CF | | 28714 |
| R452 | 680Ω | CF | | 28723 |
| R453 | 470Ω | Plessey MPD/PC | | 28524 |
| R454 | 1k3 | MO | | 28792 |
| R455 | 3k3 | CF | | 21803 |
| R456 | 1k5 | CF | | 21801 |
| R457 | 10Ω | CF | | 21793 |
| R458 | 470Ω | CF | | 21797 |
| R459 | 10Ω | CF | | 21793 |
| R460 | 10Ω | CF | | 21793 |
| R461 | 330Ω | CF | | 28721 |
| R462 | 33k | CF | | 21814 |
| R463 | 10Ω | CF | | 21793 |
| R464 | 10Ω | CF | | 21793 |
| R465 | 820Ω | CF | | 28724 |
| R466 | 22k | CF | | 21812 |
| R467 | 470Ω | CF | | 21797 |
| R468 | 220k | CF | | 21823 |
| R469 | 470Ω | CF | | 21797 |
| R470 | 390Ω | CF | | 28722 |
| R471 | 4k7 | CF | | 21805 |
| R472 | 2k7 | CF | | 28726 |
| R473 | 10Ω | CF | | 21793 |
| R474 | 220Ω | CF | | 21796 |
| R475 | 1k | CF | | 21799 |
| R476 | 1k5 | CC | | 18552 |
| R477 | 82Ω | CF | | 28717 |
| R478 | 1k2 | CF | | 21800 |
| R479 | 8k2 | CF | | 21808 |
| R480 | 10Ω | CF | | 21793 |
| R481 | 470Ω | CF | | 21797 |
| R482 | | | | |
| R483 | 22k | CF | | 21812 |
| R484 | | | | |
| R485 | 820Ω | CF | | 28724 |
| R486 | | | | |
| R487 | 2k7 | CF | | 28726 |
| R488 | 10Ω | CF | | 21793 |
| R489 | 750Ω | MO | | 28790 |
| R490 | 10Ω | CF | | 21793 |
| R491 | 470Ω | CF | | 21797 |
| R492 | 2k2 | CF | | 21802 |
| R493 | 680Ω | CF | | 28723 |
| R494 | 100k | CF | | 21819 |
| R495 | 1k5 | CF | | 21801 |
| R496 | 10Ω | CF | | 21793 |
| R497 | 10Ω | CF | | 21793 |
| R498 | | | | |
| R499 | | | | |
| R500 | | | | |
| R501 | 1k2 | CF | | 21800 |
| R502 | 3k9 | CF | | 21804 |
| R503 | 8k2 | CF | | 21808 |
| R504 | 470Ω | CF | | 21797 |
| R505 | 330k | CF | | 32357 |
| R506 | 100Ω | CF | | 21794 |
| R507 | | | | |
| R508 | 2k2 | CF | | 21802 |
| R509 | 13k | MO | | 28803 |
| R510 | 2k2 | Plessey WMP/PC | | 27188 |
| R511 | 1k5 | CF | | 21801 |
| R512 | 2k7 | CF | | 28726 |
| R513 | 100Ω | CF | | 21794 |

**TIMEBASE OS3001 (Cont.)**

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **RESISTORS** | | | | |
| R514 | 100Ω | CF | | 21794 |
| R515 | 4k7 | CF | | 21805 |
| R516 | 10k | CF | | 21809 |
| R517 | 10k | CF | | 21809 |
| R518 | 8k2 | CF | | 21808 |
| R519 | 10k | CF | | 21809 |
| R520 | 10k | CF | | 21809 |
| R521 | 10k | CF | | 21809 |
| R522 | 10k | CF | | 21809 |
| R523 | 10M | CC | | 1179 |
| R524 | 6k8 | CF | | 21807 |
| R525 | 100Ω | CF | | 21794 |
| R526 | 10k | CF | | 21809 |
| R527 | 6k8 | CF | | 21807 |
| R528 | 15k | CF | | 28727 |
| R529 | 1k5 | CF | | 21801 |
| R530 | 10k | CF | | 21809 |
| R531 | 47k | CF | ½W | 18570 |
| R532 | 390Ω | CF | ½W | 18545 |
| R533 | 6k8 | CF | | 21807 |
| R534 | 1k | CF | | 21799 |
| R535 | 4k7 | CF | | 21805 |
| R536 | 220Ω | CF | | 21796 |
| R537 | 47Ω | CF | | 28714 |
| R538 | 3k9 | CF | | 21804 |
| R539 | 4k7 | CF | | 21805 |
| R540 | 100Ω | CF | | 21794 |
| R541 | 1k | CF | | 21799 |
| R542 | 47Ω | CF | | 28714 |
| R543 | 6k8 | CF | | 21807 |
| R544 | 680Ω | CF | | 28723 |
| R545 | 1k | CF | | 21799 |
| R546 | 4k7 | CF | | 21805 |
| R547 | 33k | CF | | 21814 |
| R548 | 180k | CF | | 21822 |
| R549 | 5k6 | CF | | 21806 |
| R550 | 10Ω | CF | | 21793 |
| R551 | 56Ω | CF | | 28715 |
| R552 | 100k | CF | | 21819 |
| R553 | 2k | MO | | 26731 |
| R554 | 680Ω | CF | | 28723 |
| R555 | 6k8 | CF | | 21807 |
| R556 | 4k3 | MO | | 26723 |
| R557 | 33Ω | CF | | 28712 |
| R558 | 47Ω | CF | | 28714 |
| R559 | 100Ω | CF | | 21794 |
| R560 | 47k | CF | | 21815 |
| R571 | 22Ω | CF | | 28710 |
| **CAPACITORS** | | | | |
| C400 | 4.7pF | SM | | 4502 |
| C401 | 220pF | CE(2) | | 22379 |
| C402 | | | | |
| C403 | 470pF | CE(2) | | 22383 |
| C404 | 33pF | CE(2) | | 22370 |
| C405 | 100pF | CE(2) | | 22376 |
| C406 | 10pF | CE(2) | | 22364 |
| C407 | 33pF | CE(2) | | 22370 |
| C408 | 47pF | CE(2) | | 22372 |
| C409 | .01μF | CE(2) | 25 250V | 22395 |
| C410 | 1000pF | CE(2) | | 22387 |
| C411 | .1μF | PE | 10 160V | 31377 |
| C412 | .1μF | PE | 10 160V | 31377 |
| C413 | 100pF | CE(2) | | 22376 |
| C414 | 1000pF | CE(2) | | 22387 |
| C415 | 220pF | CE(2) | | 22379 |
| C416 | .047μF | PE | 10 250V | 31375 |
| C417 | .1μF | CE(1) | +80 −25 30V | 19647 |
| C418 | .1μF | PE | 10 160V | 31377 |
| C419 | .01μF | CE(2) | 25 250V | 22395 |
| C420 | 22pF | CE(2) | | 22368 |
| C421 | .1μF | CE(1) | +80 −25 30V | 19647 |
| C422 | .1μF | CE(1) | +80 −25 30V | 19647 |
| C423 | | | | |
| C424 | 390pF | CE(2) | | 22382 |
| C425 | 22μF | E | +50 −10 25V | 32181 |
| C427 | .01μF | CE(2) | 25 250V | 22395 |
| C428 | .01μF | CE(2) | 25 250V | 22395 |
| C429 | | | | |
| C430 | 10pF | CE(2) | | 22364 |
| C431 | 18pF | CE(2) | | 22367 |
| C432 | 6.8pF | CE(2) | 1pF 500V | 22362 |
| C433 | .01μF | CE(2) | 25 250V | 22395 |
| C434 | .01μF | CE(2) | 25 250V | 22395 |
| C435 | 6/25pF | Trimmer | | 23593 |
| C436 | 100pF | CE(2) | | 22376 |
| C437 | 100pF | CE(2) | | 22376 |
| C438 | 100pF | CE(2) | | 22376 |
| C439 | .01μF | CE(2) | 25 250V | 22395 |
| C440 | 33pF | CE(2) | | 22370 |
| C441 | .1μF | CE(1) | +80 −25 30V | 19647 |
| C444 | .01μF | CE(2) | 25 250V | 22395 |
| C448 | .01μF | CE(2) | 25 250V | 22395 |
| C449 | .01μF | CE(2) | 25 250V | 22395 |
| C450 | .01μF | CE(2) | 25 250V | 22395 |
| C451 | .01μF | CE(2) | 25 250V | 22395 |
| C453 | .01μF | CE(2) | 25 250V | 22395 |
| C462 | .01μF | CE(2) | 25 250V | 22395 |
| C463 | 4.7pF | CE(2) | | 29649 |
| C464 | .01μF | CE(2) | 25 250V | 22395 |
| C465 | 22pF | CE(2) | | 22368 |
| **TRANSISTORS** | | | | |
| TR401 | | 2N2369 | | 23307 |
| TR402 | | 2N2369 | | 23307 |
| TR403 | | BC107 | | 26790 |

**TIMEBASE OS3001 (Cont.)**

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| TR404 | | 2N3906 | | 21533 |
| TR405 | | BC107 | | 26790 |
| TR406 | | 2N3906 | | 21533 |
| TR407 | | BC108 | | 26110 |
| TR408 | | BC107 | | 26790 |
| TR409 | | 2N930 | | 21548 |
| TR410 | | 2N3906 | | 21533 |
| TR411 | | 2N3906 | | 21533 |
| TR412 | | BC107 | | 26790 |
| TR413 | | AE13 Matched Pair | | 31254 |
| TR414 | | | | |
| TR415 | | MPS 3640 | | 24128 |
| TR416 | | MPS 3640 | | 24128 |
| TR417 | | 2N2369 | | 23307 |
| TR418 | | BC108 | | 26110 |
| TR419 | | 2N2369 | | 23307 |
| TR420 | | 2N2369 | | 23307 |
| TR421 | | 2N3906 | | 21533 |
| TR422 | | 2N3906 | | 21533 |
| TR423 | | BC107 | | 26790 |
| TR424 | | BC108 | | 26110 |
| TR425 | | BC108 | | 26110 |
| TR426 | | AE15 | | 32067 |
| TR427 | | BC107 | | 26790 |
| TR428 | | 2N3906 | | 21533 |
| TR429 | | MPS3640 | | 24128 |
| TR430 | | 2N3906 | | 21533 |
| TR431 | | 2N2369 | | 23307 |
| TR432 | | 2N2369 | | 23307 |
| TR433 | | C407 | | 20388 |
| TR434 | | | | |
| TR435 | | | | |
| TR436 | | | | |
| TR437 | | 2N2369 | | 23307 |
| TR438 | | 2N2369 | | 23307 |

| Ref | Value | Description | Tol± | Part No. |
|---|---|---|---|---|
| D411 | | 1N4148 | | 23802 |
| D412 | | 1N4148 | | 23802 |
| D413 | | 1N4148 | | 23802 |
| D414 | | OA47 | | 4468 |
| D415 | | OA47 | | 4468 |
| D416 | | 1N 4148 | | 23802 |
| D417 | | 1N 4148 | | 23802 |
| D418 | | 1N 4148 | | 23802 |
| D419 | | AAZ13 | | 4472 |
| D420 | | 1N 4148 | | 23802 |
| D421 | | 1N 4148 | | 23802 |
| D422 | | 1N 4148 | | 23802 |
| D423 | 6V8 | Zener | | 4666 |
| D424 | | 1N 4148 | | 23802 |
| D425 | | 1N 4148 | | 23802 |
| D426 | | 1N 4148 | | 23802 |
| D427 | | 1N 4148 | | 23802 |
| D428 | | 1N 4148 | | 23802 |
| D429 | | 1N 3595 | | 29330 |
| D430 | | | | |
| D431 | | 1N 4148 | | 23802 |
| D432 | | 1N 4148 | | 23802 |
| D433 | | 1N 4148 | | 23802 |
| D434 | 4V7 | Zener | | 4073 |
| D435 | | 1N 4148 | | 23802 |
| D436 | | 1N 4148 | | 23802 |
| D437 | | | | |
| D438 | | 1N 4148 | | 23802 |
| D439 | | 1N 4148 | | 23802 |
| D440 | | 1N 4148 | | 23802 |

**DIODES**

| | | |
|---|---|---|
| D401 | 1N 4148 | 23802 |
| D402 | 1N 4148 | 23802 |
| D403 | 1N 4148 | 23802 |
| D404 | 1N 4148 | 23802 |
| D405 | 1N 4148 | 23802 |
| D406 | 1N 4148 | 23802 |
| D407 | 1N 4148 | 23802 |
| D408 | 1N 4148 | 23802 |
| D409 | 1N 4148 | 23802 |
| D410 | 1N 4148 | 23802 |

**MISCELLANEOUS**

| | | |
|---|---|---|
| IC401 | SN7400N | 52038 |
| L402 | Ferrite FX1242 | 26986 |
| N400 | | 26586 |
| S40 | Switch Rotary | 33340 |
| S41 | Part of R440 | |
| S42 | Switch Lever | A3/31266 |
| S44 | Switch Lever | A3/31267 |
| SKE | 50Ω B.N.C. | 1222 |

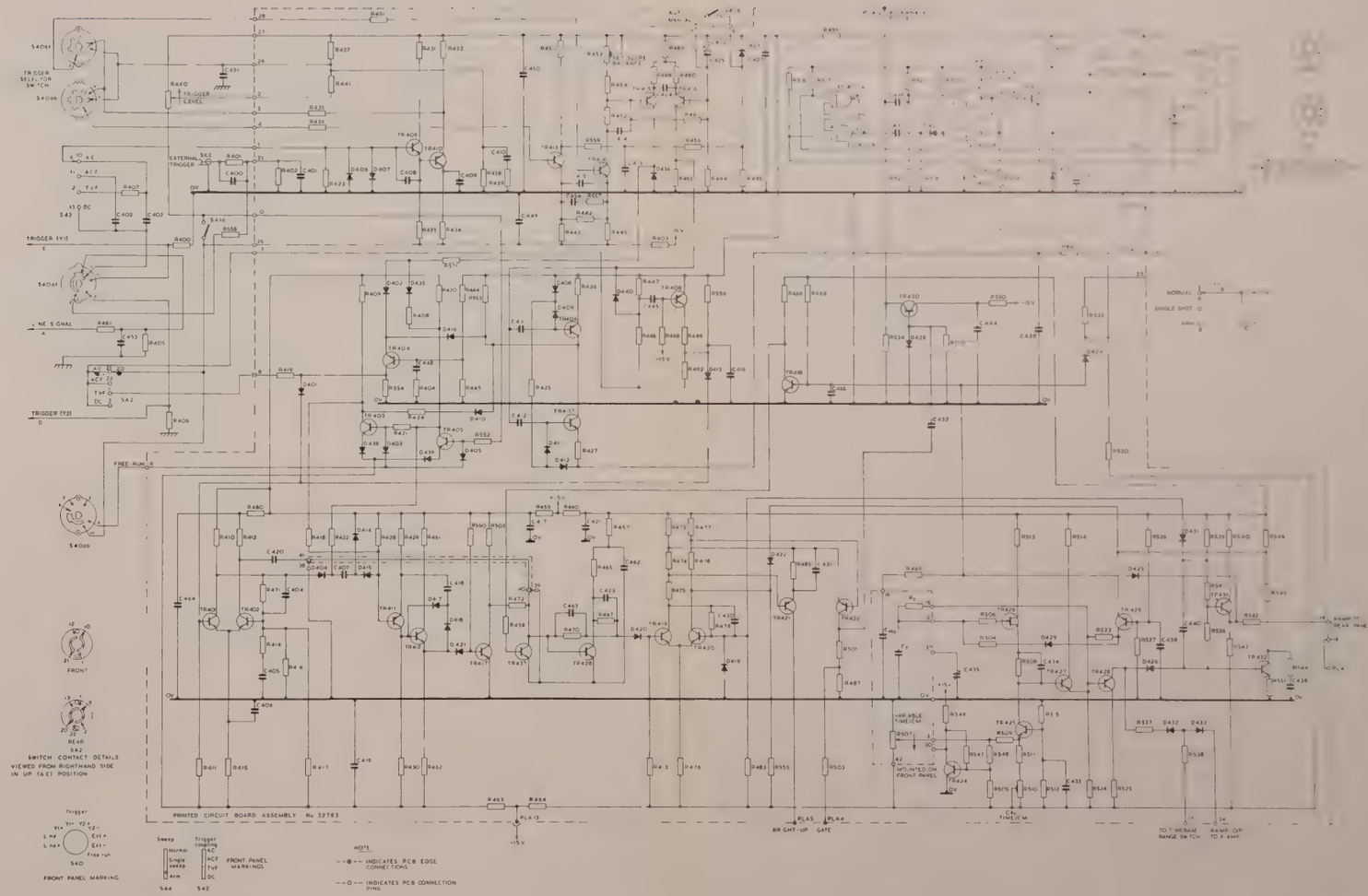



*Fig. 5 Circuit Diagram Timebase (AO/SK2339)*

### CALIBRATOR & EXTERNAL X AMP OS3001

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **RESISTORS** | | | | |
| R601 | 200k | MO. | | 28829 |
| R602 | 150k | MO. | | 28826 |
| R603 | 1M | CF. | | 31840 |
| R604 | 3k9 | CF. | | 21804 |
| R605 | 1k | | | |
| R606 | 1k | CP. Dual Pot. | | A29553 |
| R607 | 1k5 | CF. | | 28727 |
| R608 | 3k9 | CF. | | 21804 |
| R609 | 1k5 | CF. | | 28727 |
| R610 | 47k | MO. | | 28814 |
| R611 | 13k | MO. | | 28803 |
| R612 | 2k | MO. | | 26731 |
| R613 | 5k6 | MO. | | 22483 |
| R614 | 3k9 | CF. | | 21804 |
| R615 | 6k8 | CF. | | 21807 |
| R616 | 47Ω | CF. | | 28714 |
| R617 | 2k4 | MO. | | 26729 |
| R618 | 1k5 | MO. | | 26733 |
| R619 | 8k2 | MO. | | 28798 |
| R620 | 10Ω | CF. | | 21793 |
| R621 | 470Ω | CF. | | 21797 |
| R622 | 10k | MO. | | 28800 |
| R623 | 470Ω | CP. | | 28524 |
| R624 | 2k7 | MO. | | 26728 |
| R625 | 214Ω | MF. | 1 | 32248 |
| R626 | 4k3 | MO. | | 26723 |
| R627 | | | | |
| R628 | 68k | CF. | | 28716 |

| Ref | Value | Description | Tol%± | | Part No |
|---|---|---|---|---|---|
| **CAPACITORS** | | | | | |
| C601 | .1μF | CE(1) | +80 25 | 30V | 19647 |
| C602 | 8.2pF | CE(2) | 1pF | 500V | 22363 |
| C603 | 6/25pF | Trimmer | | | 23593 |
| C604 | 10pF | CE(2) | | | 22364 |
| C605 | .01μF | CE(2) | 25 | 250V | 22395 |
| C606 | 22μF | E. | +50 -10 | 25V | 32181 |
| C607 | 33μF | PE. | 10 | 160V | 31380 |
| C608 | .01μF | CE(2) | 25 | 250V | 22395 |
| C609 | .01μF | CE(2) | 25 | 250V | 22395 |
| C610 | .01μF | CE(2) | 25 | 250V | 22395 |
| **MISCELLANEOUS** | | | | | |
| TR601 | | 2N930 | | | 21548 |
| TR602 | | 2N3906 | | | 21533 |
| TR603 | | BC108 | | | 26110 |
| TR604 | | BC108 | | | 26110 |
| TR605 | | 2N3906 | | | 21533 |
| D601 | | 1N3595 | | | 29330 |
| D602 | | 1N4148 | | | 23802 |
| D603 | | 1N4148 | | | 23802 |

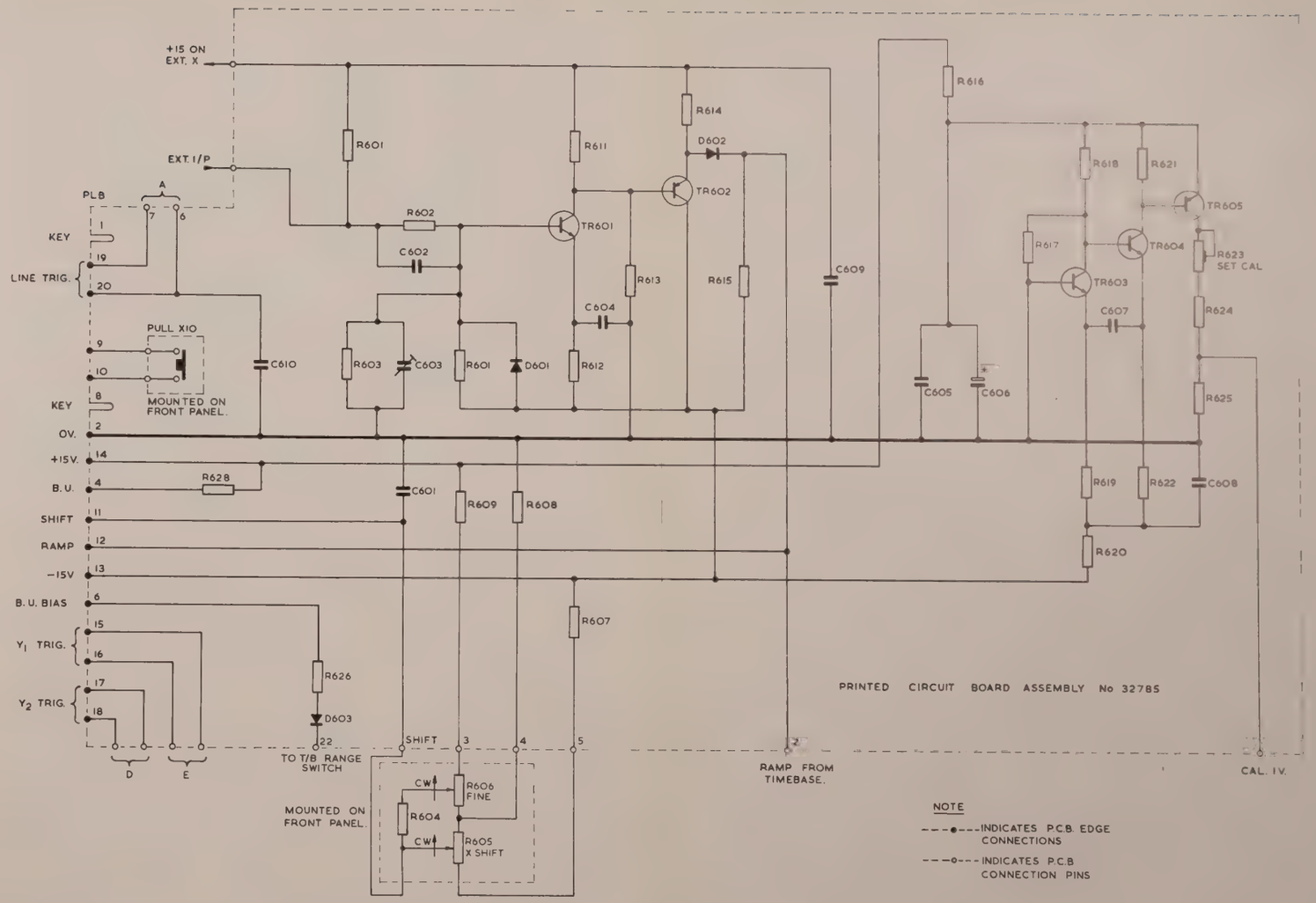



*Fig. 6 Circuit Diagram Calibrator and External X Amp (AO/SK2340)*

**BRIGHT-UP + Z MOD. OS3001**

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **RESISTORS** | | | | |
| R903 | 22k | CF | | 18566 |
| R904 | 470Ω | CF | | 21797 |
| R905 | 47k | CF | | 21815 |
| R906 | 10k | CF | | 21809 |
| R907 | 39k | CF | | 28728 |
| R908 | 2k2 | CF | | 18554 |
| R909 | 4k3 | MO | | 26723 |
| R910 | 10Ω | CF | | 21793 |
| R911 | 680Ω | CF | | 28723 |
| R912 | 4k7 | CF | | 21805 |
| R913 | 5k6 | CF | | 21806 |
| R914 | 47Ω | CF | | 28714 |
| R915 | 9k1 | MO | | 28799 |
| R916 | 100Ω | CF | | 21794 |
| R917 | 1k8 | CF | | 18553 |
| R918 | 10k | CF | | 21809 |
| R919 | 15k | MO | | 28804 |
| R920 | 82k | CF | | 18573 |
| R921 | 27k | CF | | 19054 |
| R922 | 10Ω | CF | | 21793 |
| R923 | 47k | CF | | 21815 |
| R924 | 10Ω | CF | | 21793 |
| R925 | 10Ω | CF | | 21793 |
| R926 | 10k | CF | | 21809 |
| R927 | 100Ω | CF | | 21794 |
| R928 | 1M | CP | | 26867 |
| R929 | 1M | CF | | 31840 |
| R930 | 3M3 | CF | 5 ½W | 30278 |
| R031 | 3M3 | CF | 5 ½W | 30278 |
| R932 | 3M3 | CF | 5 ½W | 30278 |
| R933 | 3M3 | CF | 5 ½W | 30278 |
| R934 | 10k | CF | | 21809 |
| R935 | 100k | CF | | 21819 |
| R936 | 47k | CF | | 21815 |
| R937 | 100k | CF | | 21819 |

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **CAPACITORS** | | | | |
| C901 | 220pF | CE(2) | | 22379 |
| C902 | .01μF | CE(2) | 25 250V | 22395 |
| C903 | .01μF | CE(2) | 25 250V | 22395 |
| C904 | 820pF | CE(2) | | 22386 |
| C905 | | | | |
| C906 | .01μF | CE(2) | 2kV | 32066 |
| C907 | 0.1μF | CE(2) | 160V | 2740 |
| C908 | .01μF | CE(2) | 25 250V | 22395 |
| C909 | .01μF | CE(2) | 25 250V | 22395 |
| C910 | .01μF | CE(2) | 25 250V | 22395 |
| C911 | .01μF | CE(2) | 2kV | 32066 |
| C912 | 2200pF | CE(2) | 20 500V | 22389 |
| C913 | .01μF | CE(2) | 2kV | 32066 |
| C914 | 2.7pF | SM | ½pF | 816 |
| **TRANSISTORS** | | | | |
| TR901 | | BC108 | | 26110 |
| TR902 | | 2N2369 | | 23307 |
| TR903 | | BCY70 | | 23354 |
| TR904 | | BC107 | | 26790 |
| **DIODES** | | | | |
| D901 | | IN4148 | | 23802 |
| D902 | | IN4148 | | 23802 |
| D903 | | IN4148 | | 23802 |
| D904 | | IN4148 | | 23802 |
| D905 | | IN4148 | | 23802 |
| D906 | | IN4148 | | 23802 |
| D907 | | IN4148 | | 23802 |
| D908 | | IN916 | | 1949 |
| D909 | | IN916 | | 1949 |
| D910 | | IN4148 | | 23802 |
| **MISCELLANEOUS** | | | | |
| L901 | | Ferrite FX1242 | | 26986 |
| N901 | | Hivac 34H | | 26845 |
| N902 | | Hivac 34H | | 26845 |

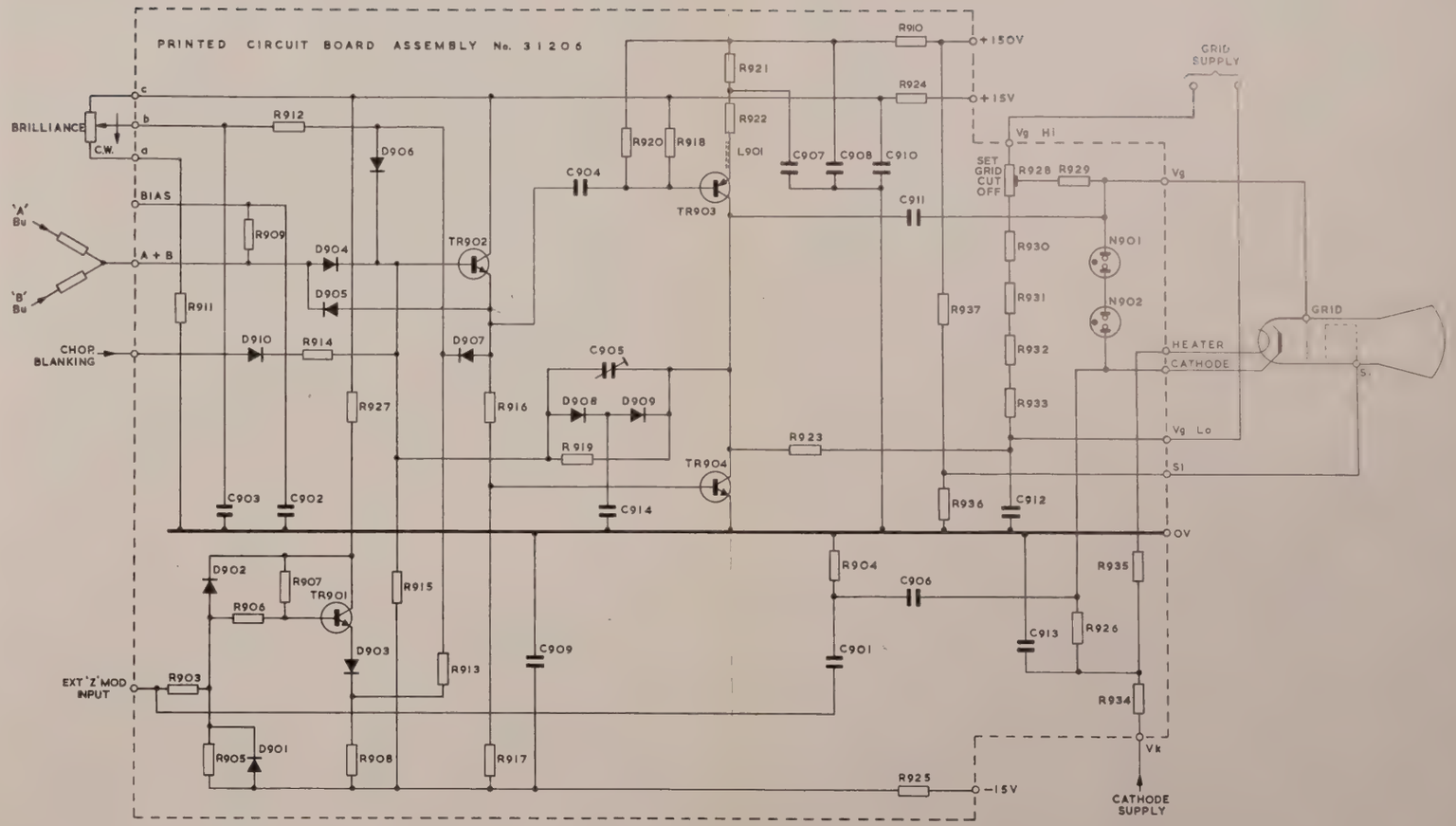



*Fig. 7 Circuit Diagram, Bright-up and Z mod. (AO/SK2319)*

## X OUTPUT AMPLIFIER OS3001

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **RESISTORS** | | | | |
| R951 | 4k7 | MO | | 26722 |
| R952 | 5k1 | MO | | 28794 |
| R953 | 3k9 | CF | | 21804 |
| R954 | 330Ω | CF | | 28721 |
| R955 | 33Ω | CF | | 28712 |
| R956 | 33Ω | CF | | 28712 |
| R957 | 100Ω | CF | | 21794 |
| R958 | 47Ω | CF | | 28714 |
| R959 | 47k | CF | | 21815 |
| R962 | 3k3 | CF | | 21803 |
| R963 | 4k7 | CF | | 21805 |
| R964 | 100Ω | CF | | 21794 |
| R965 | 680Ω | CF | | 28723 |
| R966 | 1k5 | CF | | 21801 |
| R967 | 68Ω | CF | | 28716 |
| R968 | 1k5 | CF | | 21801 |
| R969 | 100Ω | CP | | 28520 |
| R971 | 1k5 | CF | | 21801 |
| R972 | 1k | CP | | 26870 |
| R973 | 470Ω | CF | | 21797 |
| R974 | 750Ω | MO | | 28790 |
| R975 | 470Ω | CF | | 21797 |
| R976 | 3k9 | WW | 5 8W | 31244 |
| R979 | 3k9 | WW | 5 8W | 31244 |
| R981 | 1k | CF | | 21799 |
| R982 | 180Ω | CF | | 21795 |
| R983 | 15Ω | CF | | 28708 |
| R984 | 330Ω | CF | | 18544 |
| R985 | 2k2 | CF | | 21802 |
| R986 | 330Ω | CF | | 18544 |
| R987 | 100Ω | CF | | 21794 |
| R988 | 100Ω | CF | | 21794 |
| R989 | 10Ω | CF | | 21793 |
| R990 | 100Ω | CF | | 21794 |
| R992 | 100Ω | CF | | 21794 |
| R993 | 6k8 | CF | | 21807 |

| Ref | Value | Description | Tol%± | | Part No |
|---|---|---|---|---|---|
| **CAPACITORS** | | | | | |
| C951 | .01μF | CE(2) | 25 | 250V | 22395 |
| C952 | .01μF | CE(2) | 25 | 250V | 22395 |
| C953 | 560pF | CE(2) | | 125V | 33248 |
| C954 | .01μF | CE(2) | 25 | 250V | 22395 |
| C955 | .01μF | CE(2) | 25 | 250V | 22395 |
| C956 | .1μF | CE(1) | +80 −25 | 30V | 19647 |
| C957 | .01μF | CE(2) | 25 | 250V | 22395 |
| C958 | .01μF | CE(2) | 25 | 250V | 22395 |
| C959 | .01μF | CE(2) | 25 | 250V | 22395 |
| C961 | .1μF | CE(2) | 10 | 160V | 31377 |
| C963 | 47μF | E | +50 −10 | 25V | 32182 |
| C964 | 47μF | E | +50 −10 | 25V | 32182 |
| C965 | 10μF | CE(2) | | | 22364 |
| **TRANSISTORS** | | | | | |
| TR951 | | BC107 | | | 26790 |
| TR952 | | 2N3906 | | | 21533 |
| TR953 | | 2N3906 | | | 21533 |
| TR954 | | 2N3906 | | | 21533 |
| TR955 | | 2N3906 | | | 21533 |
| TR956 | | BF258 | | | 31490 |
| TR957 | | BF258 | | | 31490 |
| TR958 | | 2N2369 | | | 23307 |
| TR959 | | 2N2369 | | | 23307 |
| **DIODES** | | | | | |
| D952 | | IN4148 | | | 23802 |
| D953 | | IN4148 | | | 23802 |
| D954 | | IN4148 | | | 23802 |
| D955 | | IN4148 | | | 23802 |
| **MISCELLANEOUS** | | | | | |
| SKA | | 15 Way | | | A3/31240 |
| SKB | | 20 Way | | | A3/31241 |
| L901 | 0.5μH | Choke Cambion 3640-13-3 or 2960-24-3 | | | 33336 |

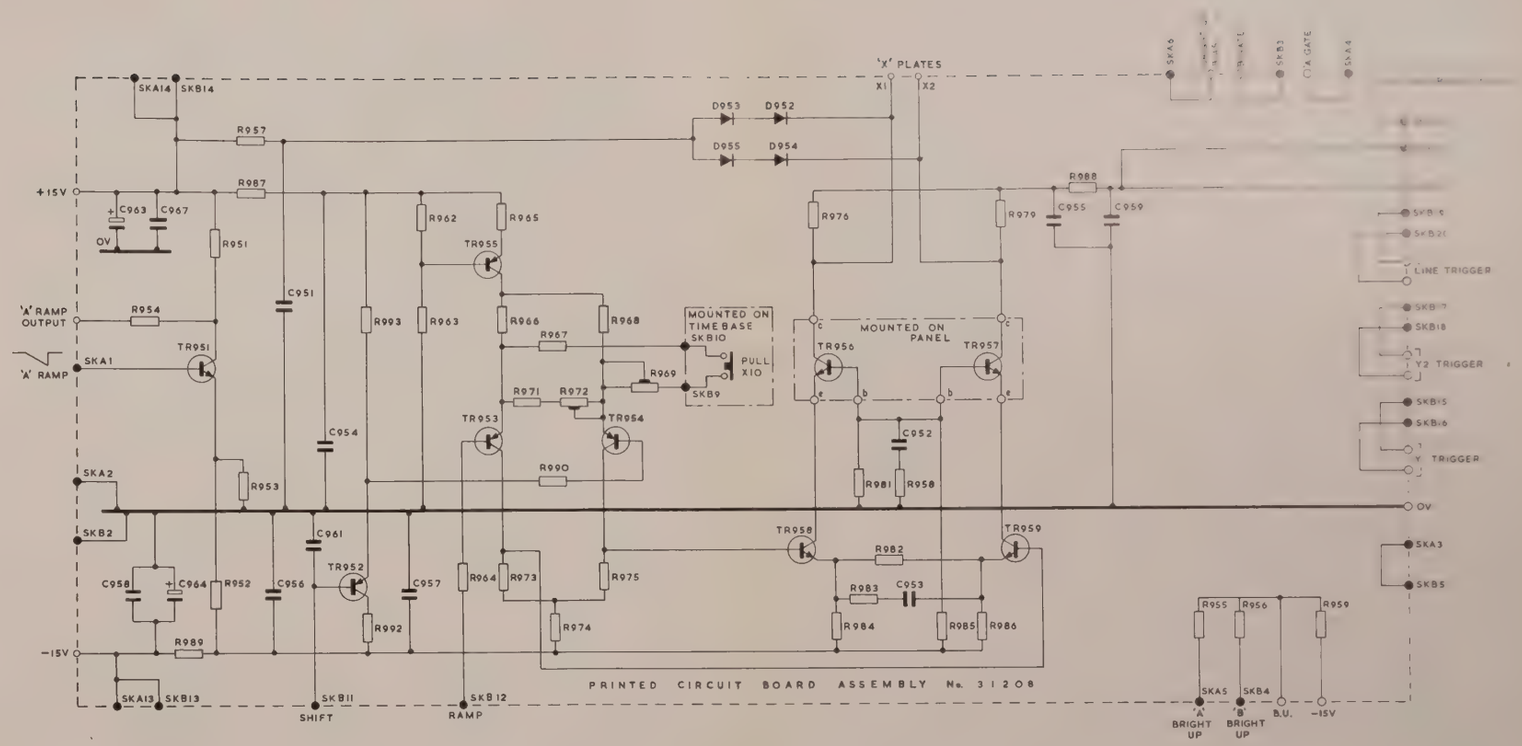



*Fig. 8 Circuit Diagram, X Output Amplifier (AO/SK2321)*

**POWER SUPPLY OS3001**

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **RESISTORS** | | | | |
| R83 | 68k | CF | | 21816 |
| R84 | 47Ω | WW | 5 6W | 18739 |
| R831 | 22Ω | CF | 5 1W | 19028 |
| R832 | 470Ω | CF | | 21797 |
| R833 | 180Ω | CF | | 21795 |
| R834 | 3k3 | CF | | 21803 |
| R835 | 1Ω | WW | | 239 |
| R836 | 0R82Ω | WW | | 18006 |
| R837 | 7k5 | MO | | 28797 |
| R838 | 1k | CP | | 26870 |
| R839 | 6k8 | MO | | 28796 |
| R840 | 820Ω | CF | | 28724 |
| R841 | 2k7 | CF | 5 1W | 19043 |
| R842 | 39k | MO | | 33286 |
| R843 | 3k6 | MO | | 26725 |
| R844 | 4k7 | CF | | 21805 |
| R845 | 1k | CF | | 21799 |
| R846 | 4k7 | CF | | 21805 |
| R847 | 7k5 | MO | | 28797 |
| R848 | 7k5 | MO | | 28797 |
| R849 | 100Ω | CF | | 21794 |
| R850 | 1k | CP | | 27156 |
| R851 | 100k | CP | | 26582 |
| R852 | 120Ω | CF | | 28718 |
| R854 | 10k | CP | | 28525 |
| R855 | 3k3 | CF | | 21803 |
| R856 | 100Ω | CF | | 21794 |
| R857 | 100Ω | CF | | 21794 |
| R858 | 1M | CF | | 31840 |
| **CAPACITORS** | | | | |
| C83 | 100 + 200μF | E | 275V | 24740 |
| C84 | 4000μF | E | 40V | 4851 |
| C85 | 4000μF | E | 40V | 4851 |
| C86 | 100 + 200μF | E | 275V | 24740 |

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| C831 | 5μF | E | +50 −10 64V | 20773 |
| C832 | 100pF | CE(2) | | 22376 |
| C833 | .01μF | CE(2) | 25 250V | 22395 |
| C834 | 3300pF | CE(2) | 20 500V | 22391 |
| C835 | 5μF | E | +50 −10 64V | 20773 |
| C836 | .01μF | CE(2) | 25 250V | 22395 |
| C837 | .01μF | CE(2) | 25 250V | 22395 |
| **DIODES** | | | | |
| D83 | | IN4003 | | 23462 |
| D84 | | IN4003 | | 23462 |
| D831 | | IN4148 | | 23802 |
| D832 | | IN4148 | | 23802 |
| D833 | | IN4148 | | 23802 |
| D834 | | IN4148 | | 23802 |
| D835 | | IN4003 | | 23462 |
| D836 | | IN4003 | | 23462 |
| **TRANSISTORS** | | | | |
| TR831 | | 2N3905 | | 20818 |
| TR832 | | 2N2369 | | 23307 |
| TR833 | | BC108 | | 26110 |
| TR834 | | BC108 | | 26110 |
| TR835 | | MM1614 | | 19320 |
| TR836 | | MM1613 | | 19323 |
| TR837 | | MJE520 | | 24739 |
| TR838 | | MJE520 | | 24739 |
| TR839 | | 2N5296 | | 28630 |
| **MISCELLANEOUS** | | | | |
| MR81 | | W04 | | 29367 |
| MR82 | | 1N4003 4 off to make MR82 | | 23462 |
| MR83 | | W02 | | 19725 |
| IC831 | | μA 723C | | 31228 |
| T83 | | Transformer, Supply | | 31924 |
| S81 | | Switch, Voltage Select. | | 29547 |

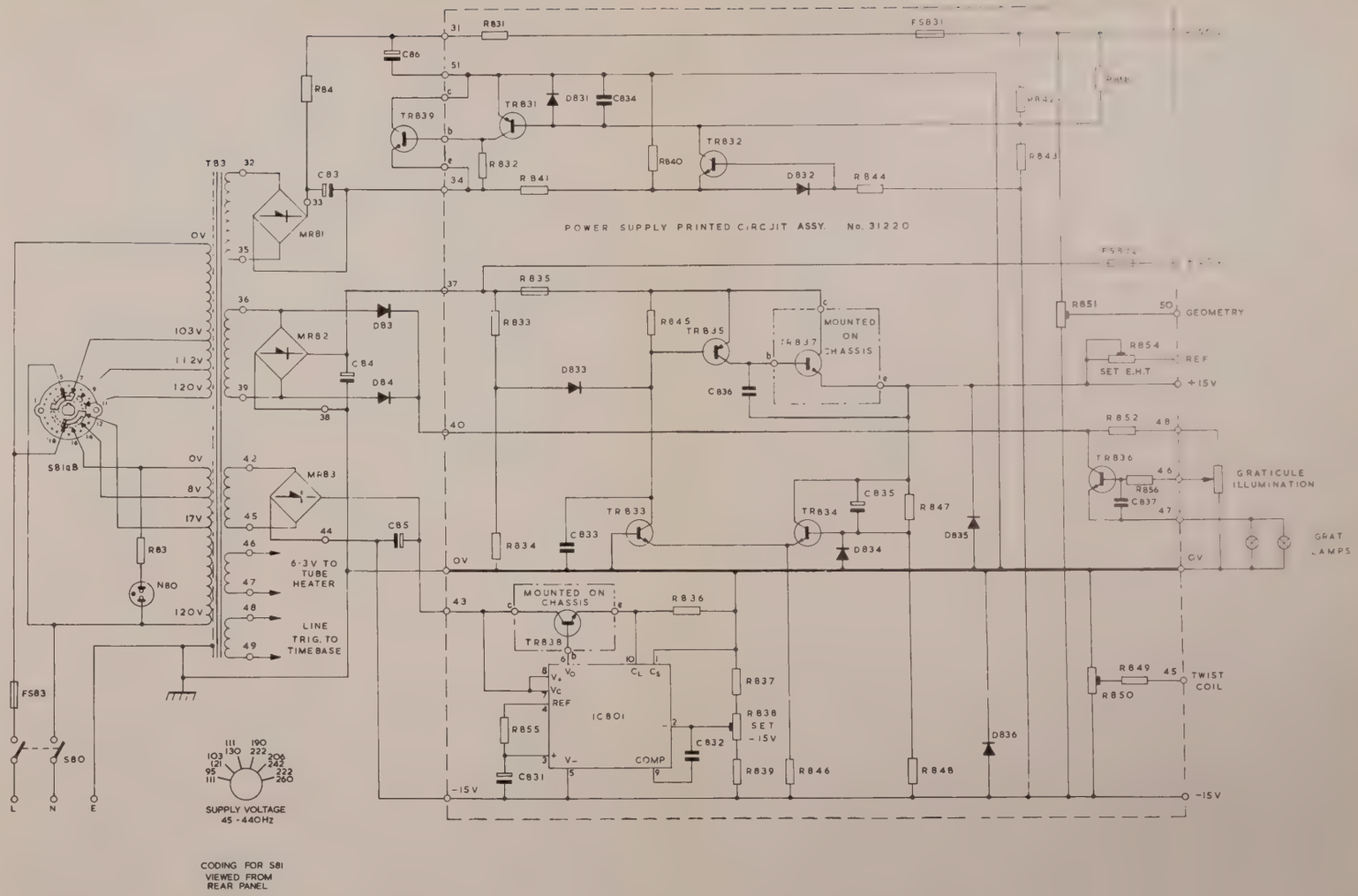



*Fig. 9 Circuit Diagram, Power Supply (AO/SK2318)*

**EHT SUPPLY OS3001**

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **RESISTORS** | | | | |
| R801 | 1M | CF. | 5 ⅛W | 31840 |
| R802 | 2M2 | CF. | 5 2W | 31237 |
| R803 | 390k | CC. | 5 ½W | 18581 |
| R811 | 120Ω | CF. | 5 ⅛W | 28718 |
| R812 | 2k2 | CC. | 5 ½W | 18554 |
| R813 | 1k | CF. | 5 ⅛W | 21799 |
| R814 | 1Ω | WW. | 5 3W | 31890 |
| R815 | 2k7 | CF. | 5 ⅛W | 28726 |
| R816 | 27k | CF. | 5 ⅛W | 21813 |
| R817 | 47k | CF. | 5 ⅛W | 21815 |
| R818 | 390Ω | WW. | 5 3W | 26766 |
| R819 | 470Ω | CF. | 5 ⅛W | 21797 |
| R820 | 470Ω | CF. | 5 ⅛W | 21797 |
| R822 | 10Ω | CF. | 5 ⅛W | 21793 |
| R823 | 1k | CF. | 5 ⅛W | 21799 |
| **CAPACITORS** | | | | |
| C801 | 500pf | CE(2) | 8kV | 26862 |
| C802 | 500pF | CE(2) | 8kV | 26862 |
| C803 | 500pF | CE(2) | 8kV | 26862 |
| C804 | 4700pF | CE(2) | 4kV | 26863 |
| C805 | .02μF | CE(2) | 1.5kV | 25223 |
| C806 | 470pF | CE(2) | 12.5kV | 31239 |
| C807 | 4700pF | CE(2) | 4kV | 26863 |
| C808 | .02μF | CE(2) | 1.5kV | 25223 |
| C809 | 1000pF | CE(2) | | 22387 |
| C812 | 12μF | E | 25V | 31238 |
| C813 | .01μF | CE(2) | 25 250V | 22395 |
| C814 | .01μF | CE(2) | 25 250V | 22395 |
| C815 | 10μF | E. | 25V | 32180 |
| C816 | .01μF | CE(2) | 25 250V | 22395 |
| C817 | 33μF | E. | 16V | 32173 |
| C818 | 0.1μF | CE(2) | | 31394 |
| **TRANSISTORS** | | | | |
| TR811 | | BC107 | | 26790 |
| TR812 | | BCY70 | | 23354 |
| TR813 | | MJE520 | | 24739 |
| TR814 | | BFY50 | | 26112 |
| TR815 | | BFY50 | | 26112 |
| TR816 | | 2N3905 | | 20818 |
| **DIODES** | | | | |
| D801 | | BY187 | | 31817 |
| D802 | | BY187 | | 31817 |
| D803 | | BY187 | | 31817 |
| D804 | | BY187 | | 31817 |
| D805 | | BY187 | | 31817 |
| D811 | | IN4148 | | 23802 |
| D812 | | IN4148 | | 23802 |
| D813 | | IN4148 | | 23802 |
| D814 | | IN4148 | | 23802 |
| **MISCELLANEOUS** | | | | |
| T801 | | Transformer E.H.T. | | A3/31334 |
| L801 | 150μH | | | 3139 |

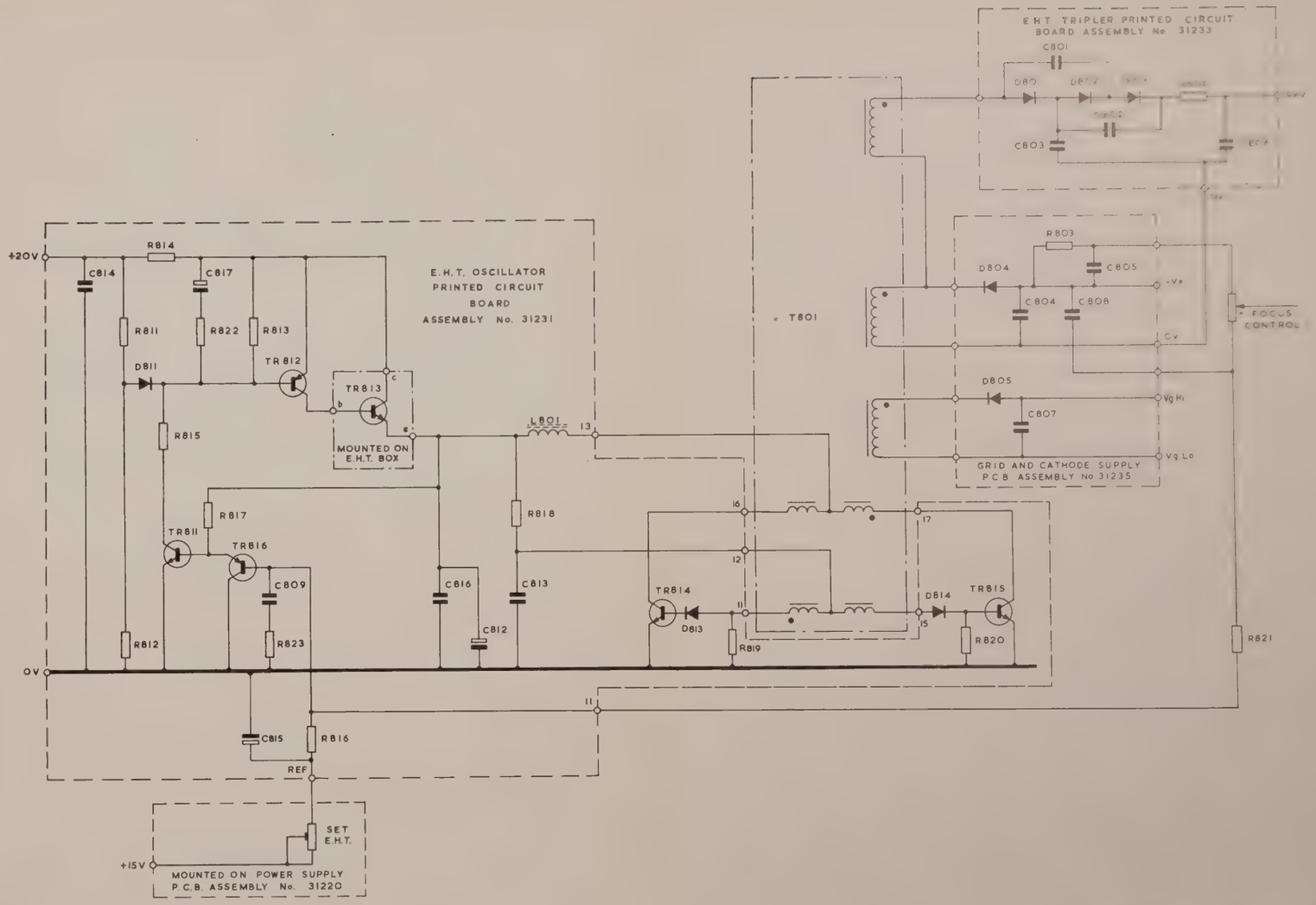



*Fig. 10 Circuit Diagram, E.H.T. Supply AO/SK 2320*

## INTERCONNECTION OS3001

| Ref | Value | Description | | Tol%± | Part No |
|---|---|---|---|---|---|
| **RESISTORS** | | | | | |
| R28 | 100Ω | CF | | | 11504 |
| R29 | 100Ω | CF | | | 11504 |
| R30 | 100Ω | CF | | | 11504 |
| R31 | 100Ω | CF | | | 11504 |
| R60 | 4k7 | CP | With 580 | | A4/31224 |
| R80 | 470k | CP | | | A4/31222 |
| R81 | 100k | CP | | | A4/31225 |
| R82 | 4k7 | CP | | | A4/31223 |
| R507 | 10k | CP | With 574 | | 31281 |
| R561 | 10M | MF | | 1 | 27305 |
| R562 | 4M99 | MF | | 1 | 29470 |
| R563 | 3M01 | MF | | 1 | 29478 |
| R564 | 1M | MF | | 1 | 26346 |
| R565 | 499k | MF | | 1 | 26342 |
| R566 | 301k | MF | | 1 | 29477 |
| R567 | 100k | MF | | 1 | 29476 |
| R568 | 49k9 | MF | | 1 | 29475 |
| R569 | 30k1 | MF | | 1 | 31261 |
| R570 | 10k | MF | | 1 | 27917 |
| **CAPACITORS** | | | | | |
| C21 | 4.7pF | CE(2) | | ½pF | 4502 |
| C456 | 68pF | CE(2) | | 5 | 4513 |
| C457 | 1uF | PF | | 1 160V | 24888 |
| C458 | .1uF | PF | | 1 160V | 24887 |
| C459 | .01uF | PF | | 1 160V | 24886 |
| C460 | 900pF | PF | | 1 125V | 24885 |
| C461 | 100pF | CE(2) | | | 22376 |

| Ref | Value | Description | Tol%± | Part No |
|---|---|---|---|---|
| **MISCELLANEOUS** | | | | |
| L83 | | | | A3/31329 |
| ILP83 | | | | 24910 |
| ILP84 | | | | 24910 |
| V83 | | CRT D14–121GH | | 31210 |
| or | | CRT D14–121GM Long Persistence | | 32259 |
| or | | CRT D14–121GH/08 Internal graticule | | 33238 |
| TP600 | | | | 24159 |
| S12 | | Part of R26 | | A4/31257 |
| S22 | | Part of R27 | | A4/31257 |
| S31 | | Switch Rotary | | 31226 |
| S43 | | Switch Rotary | | 31280 |
| S74 | | Part of R507 | | |
| S201 | | Switch slider | | 4069 |
| SKD | | BNC 50Ω | | 1222 |
| SKG | | 4mm.Hirschmann Bil.20 | | 29492 |
| SKH | | 4mm.Hirschmann Bil.20 | | 29492 |
| SKJ | | 4mm.Hirschmann Bil.20 | | 29492 |
| SKK | | 4mm.Hirschmann Bil.20 | | 29492 |
| SKL | | 4mm.Hirschmann Bil.20 | | |
| | | No Connection (OS3000 only) | | 29492 |
| SKP | | BNC 50Ω | | 1222 |
| SKY | | BNC 50Ω | | 1222 |

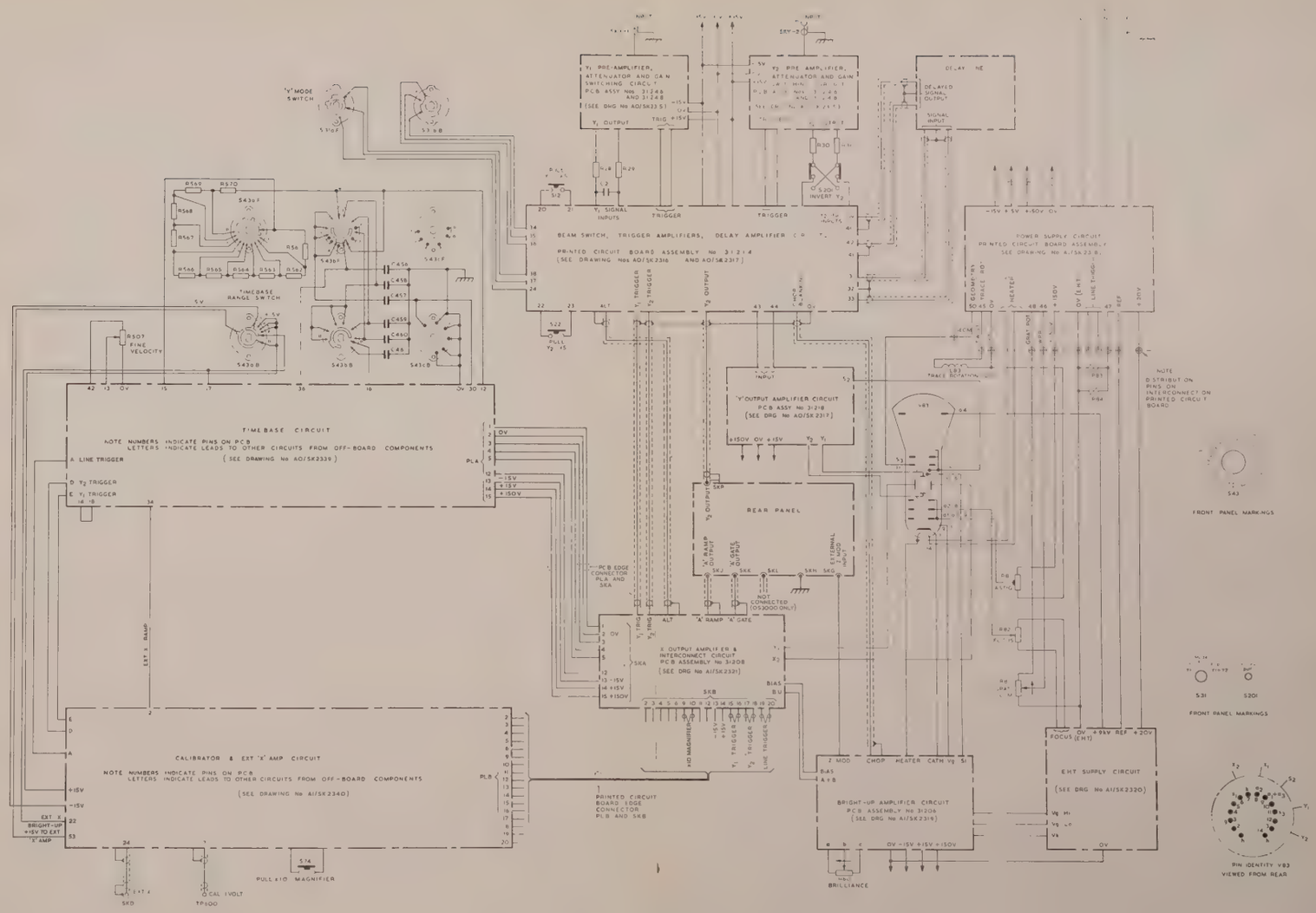

'H' MODE SWITCH
TIMEBASE RANGE SWITCH
R507 FINE VELOCITY
TIMEBASE CIRCUIT
CALIBRATOR & EXT 'X' AMP CIRCUIT
PRINTED CIRCUIT BOARD EDGE CONNECTOR PLB AND SKB
PCB EDGE CONNECTOR PLA AND SKA
Y1 PRE-AMPLIFIER, ATTENUATOR AND GAIN SWITCHING CIRCUIT
Y2 PRE AMPLIFIER, ATTENUATOR AND GAIN SWITCHING CIRCUIT
DELAY NE
BEAM SWITCH, TRIGGER AMPLIFIERS, DELAY AMPLIFIER
'Y' OUTPUT AMPLIFIER CIRCUIT
REAR PANEL
X OUTPUT AMPLIFIER & INTERCONNECT CIRCUIT
BRIGHT-UP AMPLIFIER CIRCUIT
EHT SUPPLY CIRCUIT
POWER SUPPLY CIRCUIT
FRONT PANEL MARKINGS
BRILLIANCE
PULL x10 MAGNIFIER
CAL 1 VOLT
PIN IDENTITY V83 VIEWED FROM REAR

*Fig. 11 Circuit Diagram, Interconnection (AO/SK2338)*

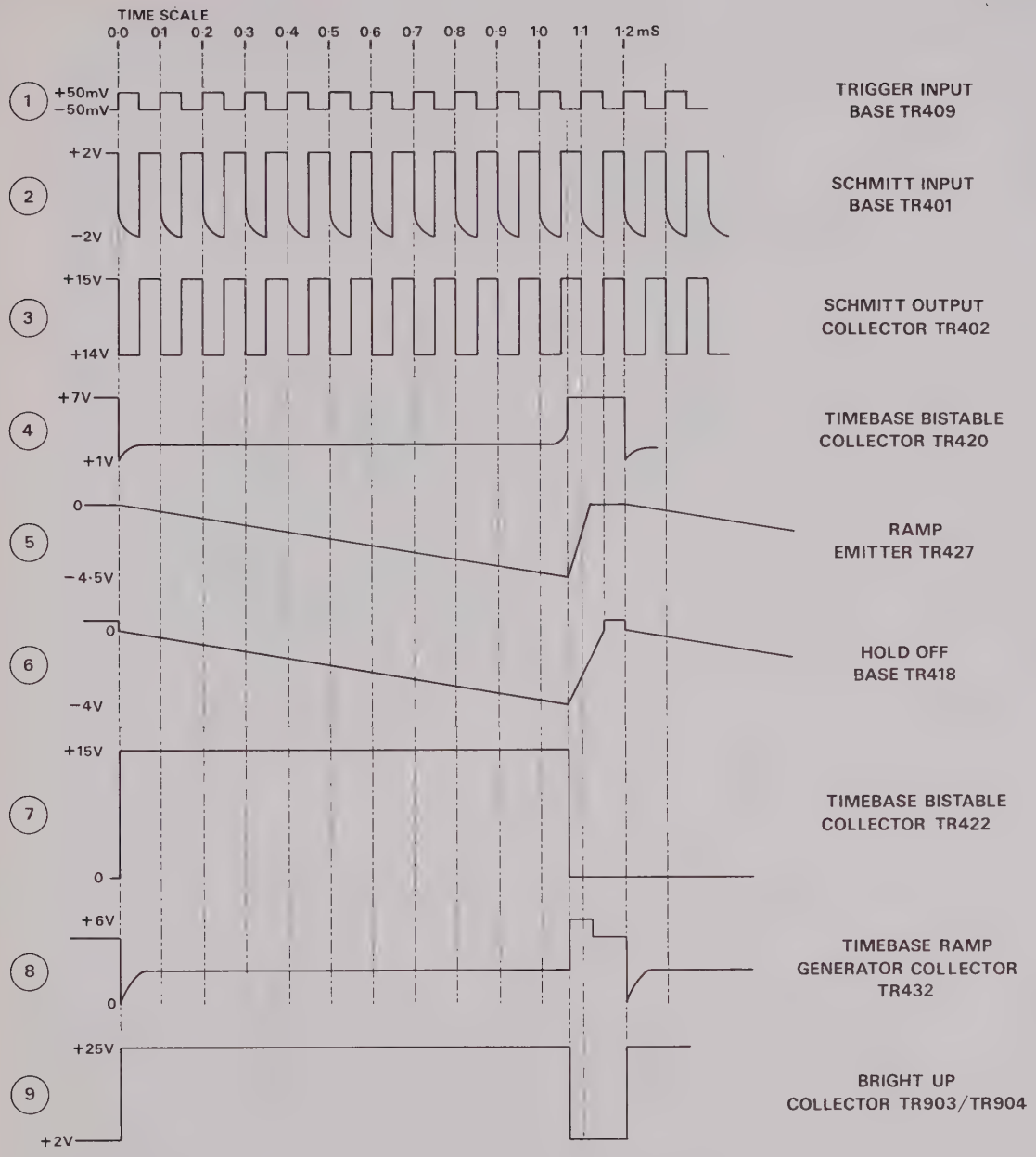



*Fig. 12 Waveform Diagram Normal Sweep*

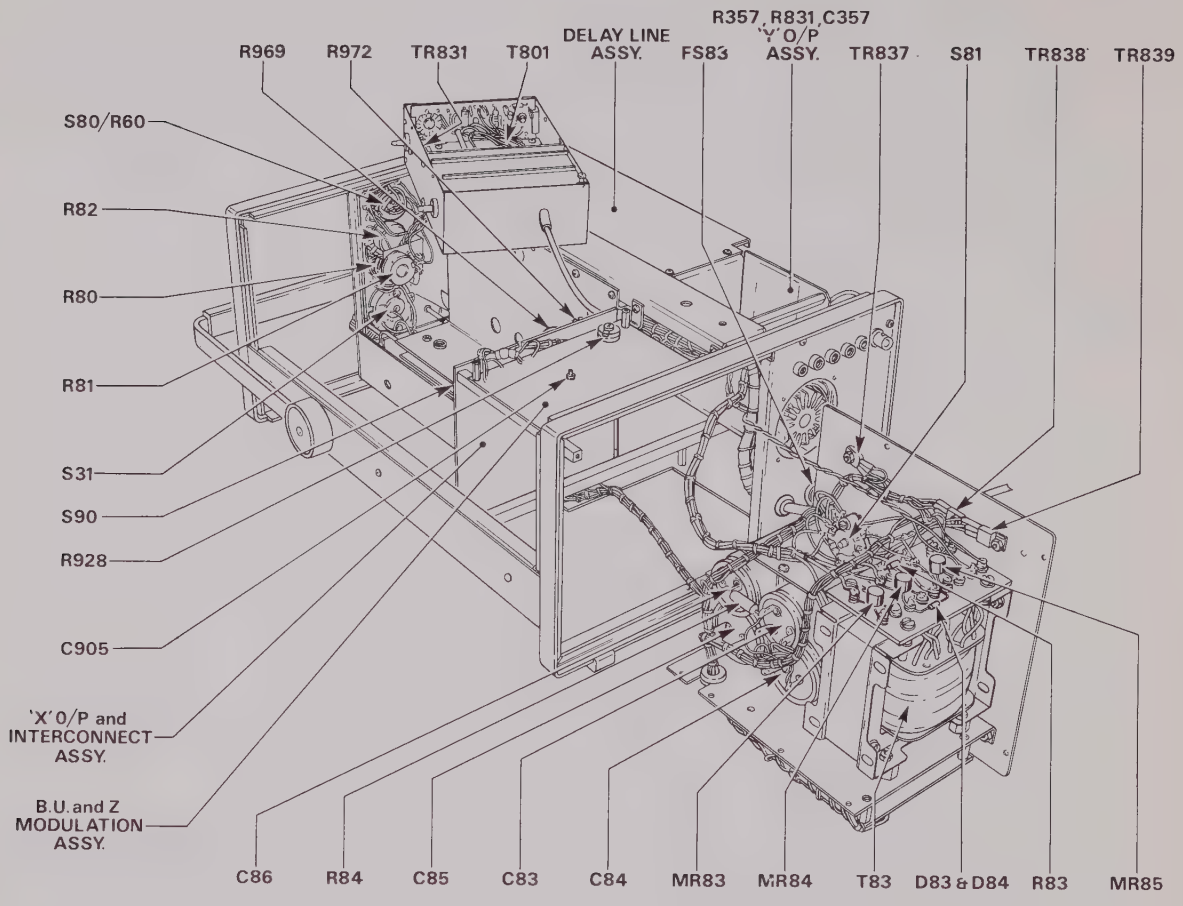
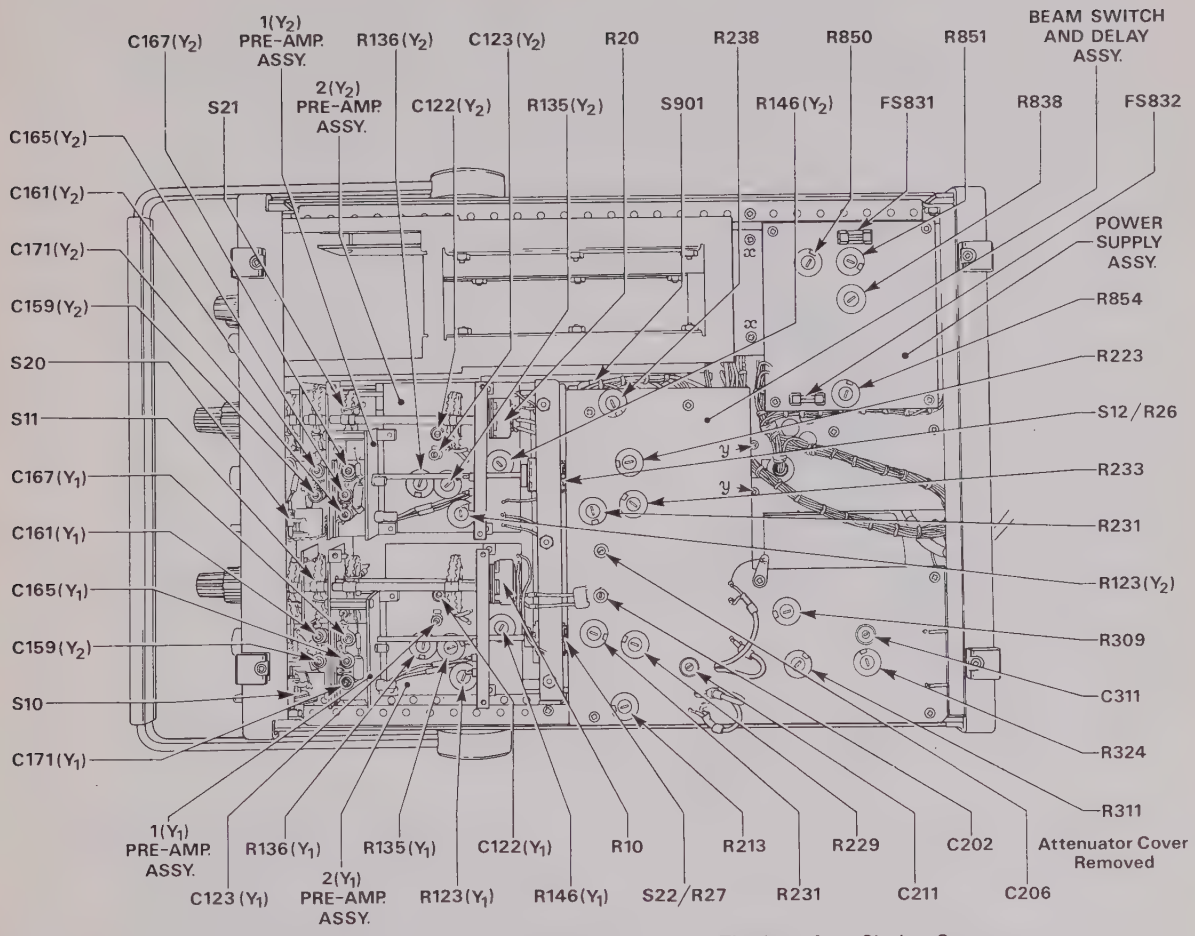



*Fig. 13 Main Frame showing access to Power supply and E.H.T. Unit*




Note: To remove Power Supply Assy. Remove Screws ∞,∞ and y,y. To remove Timebase Assy. Slacken Screws ∞,∞

*Fig. 14 Underside View*

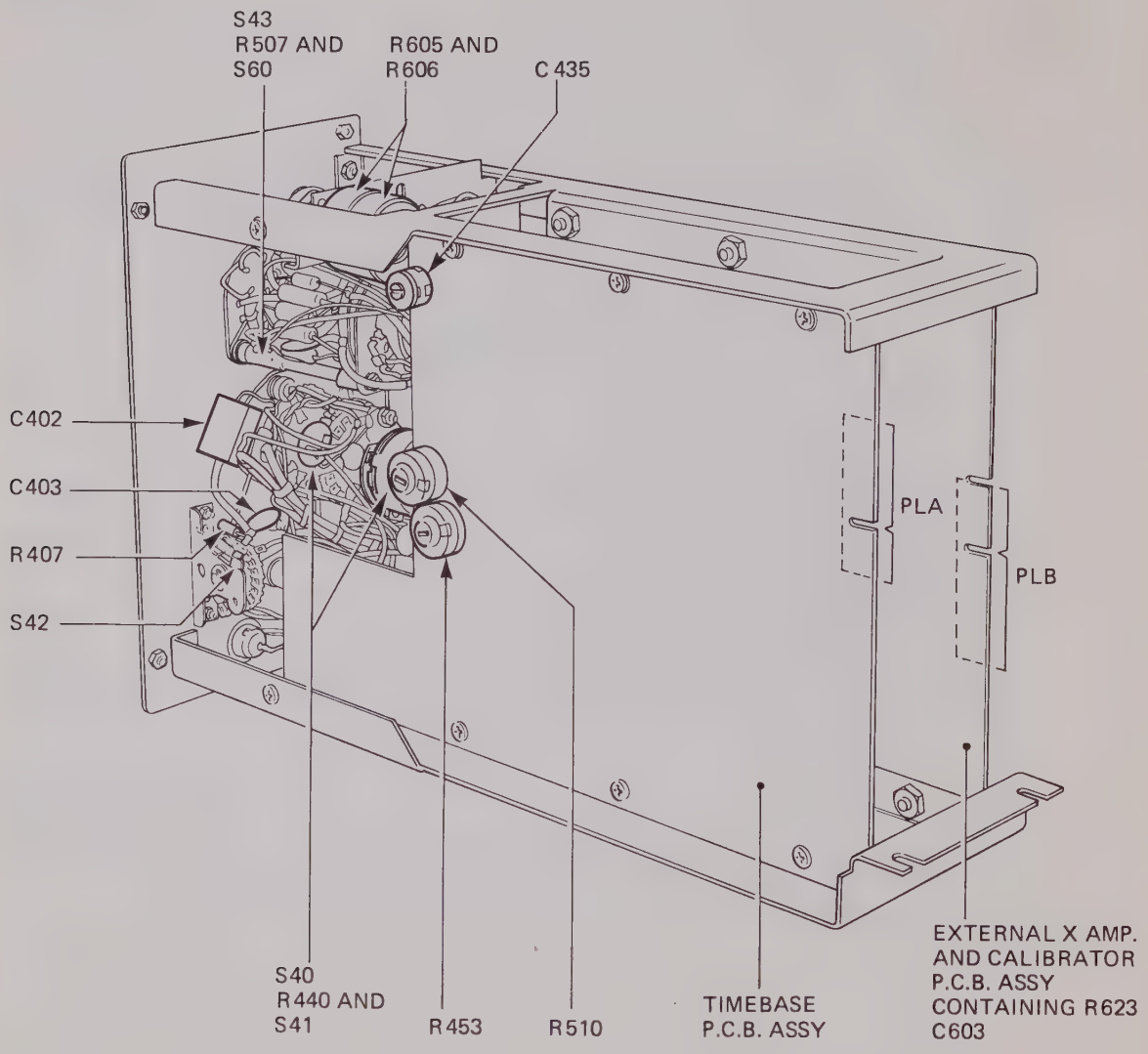



*Fig. 15 Timebase P.C.B. side*

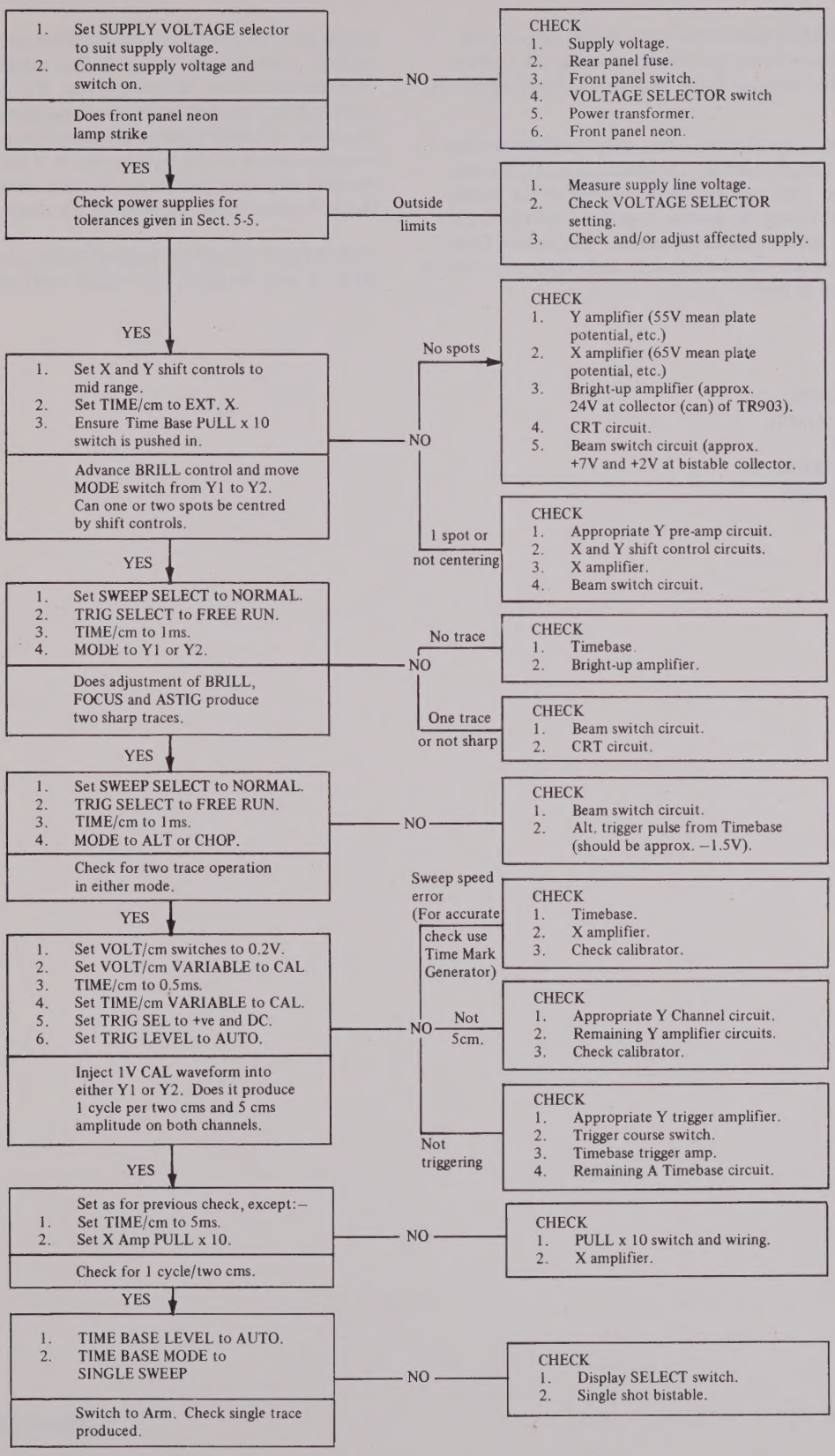

1. Set SUPPLY VOLTAGE selector to suit supply voltage.
2. Connect supply voltage and switch on.
Does front panel neon lamp strike
NO
CHECK
1. Supply voltage.
2. Rear panel fuse.
3. Front panel switch.
4. VOLTAGE SELECTOR switch
5. Power transformer.
6. Front panel neon.
YES
Check power supplies for tolerances given in Sect. 5-5.
Outside limits
1. Measure supply line voltage.
2. Check VOLTAGE SELECTOR setting.
3. Check and/or adjust affected supply.
YES
1. Set X and Y shift controls to mid range.
2. Set TIME/cm to EXT. X.
3. Ensure Time Base PULL x 10 switch is pushed in.
Advance BRILL control and move MODE switch from Y1 to Y2. Can one or two spots be centred by shift controls.
NO
No spots
CHECK
1. Y amplifier (55V mean plate potential, etc.)
2. X amplifier (65V mean plate potential, etc.)
3. Bright-up amplifier (approx. 24V at collector (can) of TR903).
4. CRT circuit.
5. Beam switch circuit (approx. +7V and +2V at bistable collector.
1 spot or not centering
CHECK
1. Appropriate Y pre-amp circuit.
2. X and Y shift control circuits.
3. X amplifier.
4. Beam switch circuit.
YES
1. Set SWEEP SELECT to NORMAL.
2. TRIG SELECT to FREE RUN.
3. TIME/cm to 1ms.
4. MODE to Y1 or Y2.
Does adjustment of BRILL, FOCUS and ASTIG produce two sharp traces.
NO
No trace
CHECK
1. Timebase.
2. Bright-up amplifier.
One trace or not sharp
CHECK
1. Beam switch circuit.
2. CRT circuit.
YES
1. Set SWEEP SELECT to NORMAL.
2. TRIG SELECT to FREE RUN.
3. TIME/cm to 1ms.
4. MODE to ALT or CHOP.
Check for two trace operation in either mode.
NO
CHECK
1. Beam switch circuit.
2. Alt. trigger pulse from Timebase (should be approx. −1.5V).
YES
1. Set VOLT/cm switches to 0.2V.
2. Set VOLT/cm VARIABLE to CAL
3. TIME/cm to 0.5ms.
4. Set TIME/cm VARIABLE to CAL.
5. Set TRIG SEL to +ve and DC.
6. Set TRIG LEVEL to AUTO.
Inject 1V CAL waveform into either Y1 or Y2. Does it produce 1 cycle per two cms and 5 cms amplitude on both channels.
NO
Sweep speed error (For accurate check use Time Mark Generator)
CHECK
1. Timebase.
2. X amplifier.
3. Check calibrator.
Not 5cm.
CHECK
1. Appropriate Y Channel circuit.
2. Remaining Y amplifier circuits.
3. Check calibrator.
Not triggering
CHECK
1. Appropriate Y trigger amplifier.
2. Trigger course switch.
3. Timebase trigger amp.
4. Remaining A Timebase circuit.
YES
Set as for previous check, except:−
1. Set TIME/cm to 5ms.
2. Set X Amp PULL x 10.
Check for 1 cycle/two cms.
NO
CHECK
1. PULL x 10 switch and wiring.
2. X amplifier.
YES
1. TIME BASE LEVEL to AUTO.
2. TIME BASE MODE to SINGLE SWEEP
Switch to Arm. Check single trace produced.
NO
CHECK
1. Display SELECT switch.
2. Single shot bistable.

*Fig. 16 Fault Localisation Chart*

# Guarantee and Service Facilities

## Section 7

This instrument is guaranteed for a period of one year from its delivery to the purchaser, covering the replacement of defective parts other than tubes, semiconductors and fuses.

We maintain comprehensive after sales facilities and the instrument can, if necessary, be returned to our factory for servicing. The type and serial number of the instrument should always be quoted, together with full details of any fault and the service required. The Service Department can also provide maintenance and repair information by telephone or letter.

Equipment returned to us for servicing must be adequately packed, preferably in the special box supplied, and shipped with transportation charges prepaid. We can accept no responsibility for instruments arriving damaged. Should the cause of failure during the guarantee period be due to misuse or abuse of the instrument, or if the guarantee has expired, the repair will be put in hand without delay and charged unless other instructions are received.

OUR SALES, SERVICE AND ENGINEERING DEPARTMENTS ARE READY TO ASSIST YOU AT ALL TIMES.

SERVICE DEPT.
ROEBUCK ROAD,
HAINAULT,
ILFORD, ESSEX.
Tel: 01-500 1000

WL 150 10 75

Manual Part No. 33427

www.manualsplus.com
1003074